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RELIABILITY OF FLEXIBLE PACKAGING FOR THERMOPROCESSED FOODS UNDER PRODUCTION CONDITIONS. PHASE I: FEASIBILITY

D. D. Duxbury, et al

Swift and Company

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Contract No. DAAG17-69-C-0160

RELIABILITY OF FLEXIBLE PACKAGING FOR THERMOPROCESSED FOODS UNDER PRODUCTION CONDITIONS. PHASE I: FEASIBILITY.

by

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July 1970

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

US ARMY MATERIEL COMMAND

General Equipment & Packaging Laboratory

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13. ABSTRACT

The objective of the two phases of effort under this contract was to establish that thermoprocessed foods in flexible packages can be readily produced under production conditions. Investigations in Phase I, encompassing analytical studies and bench model and special equipment testing, have established that the objective is feasible. Progression to the confirming engineering, line fabrication, and production phase is recommended.

Proposed product guideline formulas were revised to meet commercial production requirements. These were approved and commercial production guides were prepared for all seventeen food items. Packaging material and packaging systems specifications were established. Technical feasibility of pouch forming, filling, vacuum sealing, and processing has been established within the constraints of the developed bench model system. In fact, more complete systems were developed in order to provide a higher degree of confidence in judgment of feasibility. Quality assurance testing methodology has been established.

Details of illustrations in this document may be better studied on microfiche

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Military Rations	4		4			
Tests			8			
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Vacuum Sealing			8			
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Laminated	0		0			

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RELIABILITY OF FLEXIBLE PACKAGING FOR THERMOPROCESSED FOODS UNDER PRODUCTION CONDITIONS

PHASE I: FEASIBILITY

by

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July 1970

General Equipment & Packaging Laboratory

U. S. ARMY NATICK LABORATORIES

Natick, Massachusetts 01760

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FOREWORD

The work covered by this report was performed under Project 1J662708D552, Packaging Exploratory Development, Task 02--Design of Flexible Packaging Systems.

Flexible packaging as a substitute for rigid cans for thermoprocessed foods has numerous logistics advantages. Progress had been made to the extent that suitable rugged and impervious packaging materials are available, that storage stability has been proven, and that resistance to shipping and handling abuse is excellent. The key military advantages -- suitability for man-carry, light weight, ready-to-eat, and compatability with pockets of field clothing -- have been established.

Engineering Tests/Service Tests indicated a failure rate that, although low, was not acceptable. Examination of the nature of the defects revealed that inadequate manufacturing capabilities and control were responsible. This report covers Phase I of the contract effort to establish that thermoprocessed foods in flexible packages can be reliably prepared under production-type conditions. Based on bench models and special equipment testing, the Phase I effort concluded that it is feasible to reliably manufacture these packages and recommends progression to the engineering and production phase.

The investigations described were performed by a consortium headed by Swift and Company. Companies and locales were:

Swift & Co., Research and Development Center, Oak Brook, Illinois
Continental Can Co., Technical Center, Chicago, Illinois
Riegel Packaging Machines, Division of Riegel Paper Corp, Rockford, Illinois
The Pillsbury Company, Research Laboratories, Minneapolis, Minnesota
FMC Corporation, Engineered Systems Division, Santa Clara, California

Mr. Dean D. Duxbury of Swift and Company served as project leader. Project Officer for the U. S. Army Natick Laboratories was Dr. Rauno A. Lampi, and the Alternate Project Officer was Mr. Frank J. Rubinate, both of the Packaging Division, General Equipment & Packaging Laboratory.

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RELIABILITY OF FLEXIBLE PACKAGING FOR THERMOPROCESSED FOODS UNDER PRODUCTION CONDITIONS

PHASE I: FEASIBILITY

I. INTRODUCTION

Research and development has indicated that the use of laminated, flexible packaging materials in place of rigid, tin-coated steel plate to hermetically package thermoprocessed shelf stable foods is technically feasible resulting in lighter weight, lower volume ration items that can be carried more easily and with greater convenience by the soldier. During processing, the shape of the flexible package permits packaging a wide variety of foods and because of the shorter processing time, provides products of improved quality.

Engineering tests/service tests* indicated a package failure rate of 0.3% which was cited as a deficiency necessitating correction. These failures were clearly attributable to lack of proper mechanization and automation, comprehensive testing and quality assurance procedures and adequate sealing techniques. Before any high volume product can be permitted, the proportion of defective pouches must be reduced through the development of a reliable, automated system to form, fill, seal, and handle flexible packages for thermoprocessed foods.

The main objective of this study was to establish the feasibility of obtaining and assuring the reliability of flexible packages for thermoprocessed foods through the use of an optimally automated, continuous production system to form, fill, seal, thermoprocess, and handle the flexible packages. Reliability was to be established on a statistically sound basis and be evaluated as the ability of the production system to prepare packages with a defect rate goal of no greater than 0.01%. This effort was to encompass obtaining and assuring the reliability of the total preparation of specified thermoprocessed food items from procurement of ingredients and materials through the necessary intermediate unit operations to the point where the package is ready for placement into the paper overwrap envelope. This study was to include all actions necessary to obtain reliability.

The specific objectives for Phase I of this Contract were: to develop specific food preparation, packaging, and processing concepts for seventeen thermally-processed food items; to demonstrate equipment functions by means of bench models and/or analytical studies; to evaluate the creditability of the engineering principles selected; and to establish assurance and probability of success for constructing a single packaging and processing line modified for handling each of these food products. Recommendations for progression to the engineering and production effort were also to be made to the Contracting Officer at the conclusion of this phase.

This report covers Phase I of this effort as carried out by research and development groups from Swift and Co.; Continental Can Co.; Pillsbury Co.: Riegel Paper Corporation; and FMC Corporation.

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*Paschal, H. H., J. H. Cantrell, and R. D. Ezzard, Integrated engineering and service test of Meal, Ready-to-Eat, Individual (Intermediate Conditions). USATECOM Project No. 8-3-7400-06/07/08. U.S. Army General Equipment Test Activity, Fort Lee, Virginia. June 1967. 106 pp.

II. TECHNICAL CONSIDERATIONS

A. General Approach.

The complexity of the engineering problems in developing a continuous production system to form, fill, seal, thermoprocess, and handle flexible packages for thermally processed foods is exemplified in the Organizational/Function Chart shown as Figure 1. The objectives of this study because of its complexity were broken down into tasks with major effort being assigned to representative research groups. Assignment of the objectives to tasks was as follows:

1. The food preparation and processing concepts including recipe modifications for all seventeen food items (food items 1 to 12 Task A, bakery items 13 to 17 Task B).

2. Technical feasibility of the packaging system (Tasks C, D, & DD).

   a. Machinability of the laminate (Tasks C and DD).

   b. The package form and preseal method (Task DD).

   c. The vacuumizing and transfer mechanisms to and from the vacuum unit or function (Task D).

   d. The final seal method (Task D).

   e. Conveying and transfer requirements and procedures (Task D).

   f. A method for filling pumpable products (Task DD).

   g. The method for filling extrudable and placeable products, bread, frankfurters and sausages through bench modeling and/or method analysis to indicate feasibility or nonfeasibility of automated approach (Tasks DD and H).

3. The technical feasibility of the thermoprocessing system (Tasks E and EE).

   a. Basic requirements for retort racks, retort loading and unloading (Task E), retorts and retort cars (Task EE), drying tunnel and if required, the overwrap apparatus (Task E).

   b. Retort rack designs (Task E).

   c. Retort rack loading and unloading concepts (Task E).

RELIABILITY OF FLEXIBLE PACKAGING FOR THERMOPROCESSED FOODS UNDER PRODUCTION CONDITIONS—PHASE I: FEASIBILITY

U. S. ARMY NATICK LABORATORIES CONTRACT NO. DAAG 17-69-C-0160

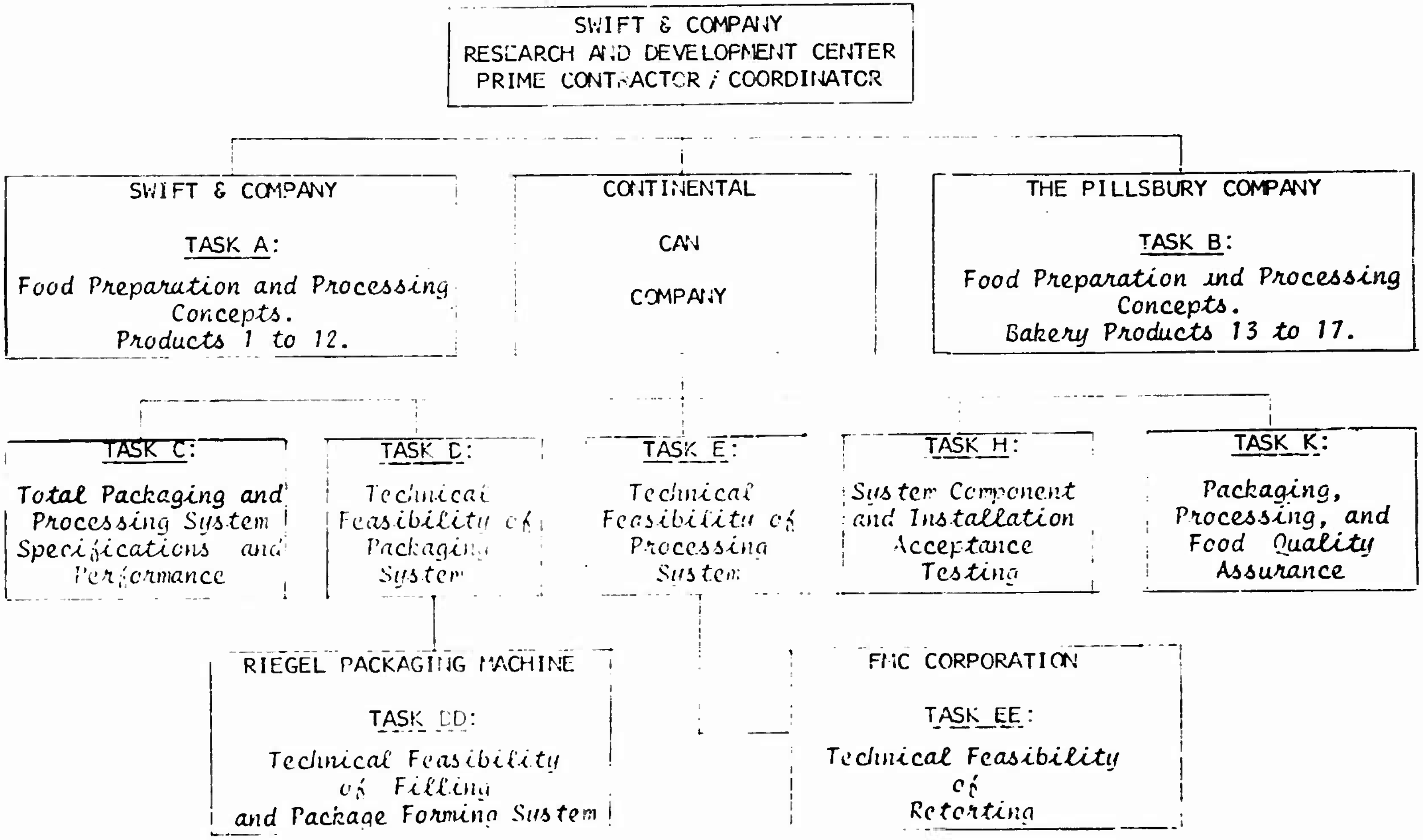


FIGURE 1. ORGANIZATIONAL/FUNCTION CHART.

4. All test and inspection procedures necessary to provide assurance that the reliability levels can be established on a statistically sound basis (Tasks H and K).

The above task assignments have been assigned to representative research groups as follows (refer to Figure 1 for organizational relationships):

Task A Food Preparation and Processing Concepts, Products 1 through 12 (Swift and Company).

Task B Food Preparation and Processing Concepts, Bakery Products 13 through 17 (The Pillsbury Company).

Task C Total Packaging and Processing System Specifications and Performance Evaluation (Continental Can Company).

Task D Technical Feasibility of Packaging System (Continental Can Company).

Task DD Technical Feasibility of Filling and Package Forming System (Riegel Packaging Machines).

Task E Technical Feasibility of Processing System (Continental Can Company)

Task EE Technical Feasibility of Retorting (FMC Corporation).

Task H System Component and Installation Acceptance Testing (Continental Can Company).

Task K Packaging, Processing and Food Quality Assurance Planning (Continental Can Company).

This approach utilizes the capabilities of leading research groups in the areas of their specialties and provides the highest degree of competency in each area of investigation. Representatives from each of these companies worked together as a team in order to resolve interface problems as well as specific problems assigned to their respective tasks.

B. Experimental Approach

The effort under each task was further detailed.

Task A Food Preparation and Processing Concepts — Products 1 through 12 (Nonbakery items).

1. Establish commercial production guides.

2. Develop bench model formulas using commercial production guides.

3 Acceptance testing of final products.

Task B Food Preparation and Processing Concepts – Products 13 through 17 (Bakery items).

1. Establish commercial production guides.

2. Develop bench model formulas using commercial production guides.

3. Acceptance testing of final products.

Task C Total Packaging and Processing System Specifications and Performance

1. Establish detailed system specifications and requirements.

2. Evaluate final closure pouch seal methods (laboratory).

3. Coordinate with Tasks D and E.

4. Procure packaging materials for all Tasks.

Task D Technical Feasibility of Packaging System.

1. Establish basic packaging module requirements.

   A. Form and preseal pouches
   B. Fillers and transfer mechanism evaluation
   C. Vacuumizing and final seal evaluation (bench model)

2. Establish transfer method from fill module to final seal module.

3. Establish vacuum and final seal method.

4. Engineer vacuum and final seal module.

5. Acceptance testing of the above systems.

Task DD Technical Feasibility of Filling and Package Forming System

1. Test machinability of laminate.

2. Bench model filler module for pumpable products.

3. Bench model filler module for extrudable products.

4. Bench model filler module for placeable products.

5. Establish preseal methods.

6. Bench model filler modules for frankfurters and sausages (manual).

7. Bench model filler module for bread.

8. Acceptance testing of above systems.

Task E Technical Feasibility of Processing System.

1. Establish basic module requirements for rack loading and unloading, retort racks, and drying tunnel.

2. Jury rig retort racks and carriers. Also interface with Task EE.

3. Acceptance testing.

Task EE Technical Feasibility of Retorting.

1. Establish feasibility and design parameters of retort and retort control modifications as required.

2. Establish feasibility and design retort cars.

3. Establish feasibility and design unit for vacuum leak test.

Task H System Component and Installation Acceptance Testing.

Task K Packaging, Processing and Quality Assurance Planning.

1. Prepare detailed packaging, processing, and food quality assurance plan.

2. Evaluation and feasibility determination of quality assurance procedures.

III. RESULTS AND DISCUSSION

General Summary of Results

Proposed production guides for all 17 products have been evaluated and revised as required for commercial production, and commercial production guides have been prepared for use in the engineering and production phases. Laminate material has been evaluated for use in pouch forming, filling, sealing, and processing and found acceptable for use in future phases. The proposed packaging system has been evaluated in a modular system using pouch carriers and racks for pouch control and restraint during transfer and processing and has been found to be feasible. Filling of all 17 food items has been evaluated on bench model fillers. Bench model testing was not considered adequate to determine overall feasibility of the package forming and filling system; therefore, a more complete system of forming and filling the pouch on a modified test machine was tested and found to be feasible at 30 pouches per minute for all products. Retorting of the food items in flexible packages was also found feasible and within the range of present practice and equipment capabilities, except for bakery items which require a special differential pressure control system. Such a control system developed under this contract. Vacuum leak detection of the finished pouch was not found to be feasible with technology available during this phase. Quality assurance procedures have been refined and are proposed to be followed during future phases of this contract. Testing accomplished during Phase I of this contract was consistent with those for bench model systems testing. Even though a more complete system was developed to gain further confidence of judgement there was insufficient time during this phase to accomplish statistical evaluation of all systems.

Feasibility of all systems has been determined to the extent possible within limits of bench model systems, and it is proposed that effort continue to the engineering and production phases and that the systems discussed in more detail in the following tasks be used during future phases of this contract.

Task A Food Preparation and Processing Concepts – Products 1 through 12.

The proposed production guidelines for Beans in Tomato Sauce, Beef Loaf, Beef Steak, Beef Stew, Sliced Beef in Barbecue Sauce, Chicken Ala King, Ham and Chicken Loaf, Frankfurters, Ground Beef with Pickle Flavored Sauce, Pork Sausage, and Pineapple in Syrup were evaluated and revised as necessary. Commercial Production Guides, based on these evaluations, were established and prepared. Bench model lots of product were proposed using the established production guides for use in filling tests, pouch sealing tests, leak tests and bio-tests, and product acceptance testing. These products have been evaluated and approved by flavor acceptance panel testing and by U. S. Army Natick Laboratories.

It is recommended that these commercial production guides be used in future effort on this contract.

Task B Food Preparation and Processing Concepts – Products 13 through 17.

In this task the proposed production guidelines for Pound Cake, Chocolate Nut Cake, Fruit Cake, Orange Nut Cake, and Bread were evaluated and revised; commercial production guides were then established. These products have been produced using bench model systems for filling tests and acceptance testing by a flavor acceptance panel and have been approved by the U. S. Army Natick Laboratories.

A differential pressure sensing and controlling method for retort processing was developed under this task to achieve proper product texture and shape and to insure pouch seal integrity during water retort processing. This was necessary since "prior art" was based on a steam retort system rather than a water retort system.

It is recommended that these commercial production guides in conjunction with the differential pressure control mechanism described under this task be used for all bakery products in future effort on this contract.

Task C Packaging Systems Specifications Performance.

Laminate material was validated against specifications for use throughout Phase I. Its compatability with the critical food products, production and thermoprocessing bench modules was established. The relationships of material seal characteristics to assure final package reliability were successfully demonstrated. Packaging systems specification guidelines were initiated for the purpose of defining performance criteria of the package fabrication, filling and processing systems.

Task D Technical Feasibility of Packaging System

We have demonstrated the practicality of automatically removing filled pouches from the form/fill machine, transferring them to a unique system of rigid carriers, and subsequently vacuumizing and top sealing to complete the packaging of the flexible pouched products. The transfer mechanism was designed, built, and demonstrated during Phase I of this contract. The device for inserting filled pouches into the rigid carriers is a simple mechanical apparatus which was not deemed necessary to build for purposes of establishing feasibility. The vacuumizing and sealing machine is a major modification of a standard vacuumizing and closing machine for irregular shaped metal cans. The initial degree of uncertainty of vacuumizing and sealing was such that a machine was completely modified for this purpose and successfully demonstrated. As a result of this activity, it is recommended that the apparatus described under this task be completely developed and used during the remainder of this program.

Task DD Technical Feasibility of the Filling and Package Forming System

This study demonstrated the feasibility of filling all 17 food products into reliable pouches formed from 0.5-mil polyester, 0.35-mil aluminum foil, and 3-mil polyolefin laminate at the specified 30 to 60 pouches per minute with a minimum contamination of the final top seal area (contract requires a minimum of 30 per minute). Modifications in the pouch opening operation to eliminate possible mechanical damage to the pouch and top seal contamination at rates of 60 pouches per minute may be necessary in Phase II. Known procedures which prevent this contamination are satisfactory at fill rates of 30 to 45 pouches per minute, but are too slow for filling 60 pouches per minute.

We are confident that the equipment developed and evaluated is feasible for pouch forming (laminate machinability) and filling without pouch damage or top seal contamination at rates of 30 to 45 pouches per minute and possibly as high as 60 pouches per minute. It is recommended that the proposed pouch forming machine and fillers be constructed and used in Phase II of this contract.

Task E Technical Feasibility of Processing System

We have designed, built, and successfully demonstrated the feasibility of pouch carriers and racks for confining, controlling, and transporting the shapeless flexible pouch through the entire packaging and thermal processing system. We recommend that these carriers and racks as described in this task be used during Phase II of this contract.

Task EE Technical Feasibility of Retorting

It has been established that retorting of the flexible pouches contained in carriers and racks as described in Tasks E and EE is feasible. The temperature and pressure requirements are within the range of present practice insofar as sensing, measuring, controlling, and recording temperature and pressure are concerned.

The proposed vacuum leak detection method has been found unsatisfactory for a number of items, although it is hoped that it will be usable for bakery products and frankfurters.

Tasks H and K
System Component and Installation Acceptance and Quality Assurance

We have conducted limited acceptance tests on various stages of the production procedures concerning laminate material, machinability of the laminate for pouch forming, product filling, pouch top sealing, thermoprocessing, and pouch physical characteristics during this phase. These limited acceptance tests have demonstrated feasibility of various stages based on judgment rather than sequential operation based on statistical evaluation

of samples as described in Task K. Production stages considered to be demonstrated as feasible, to the extent that progression to future phases is recommended, are laminate material to be used, machinability of the laminate for pouch forming, product filling, and top sealing techniques to produce packages meeting physical requirements of the final pouch.

We believe that the degree of testing initially planned was optimistic with a bench model system. Bench model systems were not adequate for statistical testing. We had to develop a more complete system during Phase I. Specifically, Tasks H and K as outlined in this report are too comprehensive and/or specific solely for the demonstration of feasibility. Statistical data that will permit reliable prediction of the performance of the various modules and the complete system will be based on production phases.

Accordingly the report on Task H indicates feasibility of different modules on a qualitative assessment basis rather than sequential statistical tests as described in Task K. Task K has been evaluated during Phase I and its recommendations will be used as control criteria during production phases to establish the degree of reliability of the developed system on a statistical basis.

SPECIFIC RESULTS AND CONCLUSIONS

Task A Food Preparation and Processing Concepts – Products 1 through 12

Proposed guideline formulas were revised, approved by the U. S. Army Natick Laboratories, acceptance tested and evaluated by a 10-member sensory panel using a 9-point hedonic scale. Bench model formulas were developed and used in Tasks C, D, and DD. Commercial production guides were prepared for the 12 food items under this task. These commercial production guides are considered to be acceptable and commercially feasible for use in the automated system for thermoprocessed foods in flexible packages, and it is recommended that these be used in future phases.

In the development of preparation and processing concepts, prior art in canned foods processing was used in modifying the proposed guideline formulas, the development of bench model formulas, and preparation of the commercial production guides. These areas of investigation and resulting changes from the proposed guideline formulas are discussed below.

Establishing Commercial Production Guides.

Initial evaluation of the proposed guideline formulas indicated that revisions were necessary for product compatibility with commercial production systems. Considerable improvement was made in order to meet the desired specifications and requirements for a commercial automated system for thermoprocessed foods in flexible packages. The final accepted and approved commercial production guides are shown in Tables A-I through A-XII, pages 15 to 26.

The proposed guideline formulas have been modified and established as commercial production guides. Revisions in these formulas are discussed below. All formulation quantities have been converted to percent by weight rather than gallons, pounds, and ounces for convenience and standardization.

Beans in Tomato Sauce

The tomato and onion contents of the existing guideline formula were specified with erroneous quantity terminology and were corrected. The emulsifier was deleted since it was not found to be necessary. Black pepper was added to improve flavor unacceptability. Presoaking conditions were modified to increase the water pickup from 80% to 100%; this raised the hedonic rating through improved texture of the beans and consistency of the sauce.

Beef Loaf

Level of beef used was reduced from 80% to 74.2%, beef juices were added at 10%, and cracker meal was reduced from 10% to 5% to improve texture of this product. The addition of beef juices as well as addition of salt at 0.5%, hydrolyzed vegetable protein (Nestle's 4-BE) at 0.2% and white pepper at 0.1% improved the flavor acceptance of this product.

Beef Steak

Swift's "Economy Cut" grade beef ribeye rolls with lip removed were used and specified since higher grade ribeyes would not withstand the extensive retorting without an extreme breakdown in texture. The maximum dimensions of the steaks were established as 5/8" thick, 5" length, 2-5/8" width and a weight of 5 ± 1/2 ounces in order to mechanically fill them into the pouch. Precooking for shrink in proper size restricting casings and molds to an internal meat temperature of 160° to 170°F was accomplished in a smokehouse. Presearing of the steaks prior to filling in pouches was tried but eliminated because it resulted in a bitter flavor of the finished product. A seasoning of 98% salt and 2% pepper was sprinkled on each steak at a level of one level teaspoon (1.33% by weight) per steak to improve flavor acceptance.

Beef Stew

Vegetable particle size, starch level, type of starch, seasonings, and coloring were established for the total formula. The total formula is filled in a two-stage operation with the gravy-vegetable mixture being pumped into the pouch prior to volumetrically filling of the meat to meet established specifications.

Beef Slices in Barbecue Sauce

The beef used is the same as for beef steaks above with the beef sliced 1/8" to 1/4" thickness rather than the specified 1/16" to 1/8" to permit mechanical filling and distinct slices in the final product. The barbecue sauce was modified by adding 1.0% starch and reducing the water by 1.0% to improve sauce consistency acceptability.

Chicken Ala King

Chicken fat was used in place of vegetable oil, rice flour and carboxymethyl-cellulose in place of corn starch, and celery salt and chicken flavoring were added to improve flavor and sauce consistency acceptability.

Chicken Loaf

Level of chicken was decreased from 75% to 66.18%, chicken fat was reduced from 10% to 5%, chicken broth was added at 10% level, egg whites increased from 10% to 12.5% and gelatin added at 0.5% to improve flavor acceptability and loaf texture or consistency.

Ham and Chicken Loaf

Chicken broth replaced 5% of the cracker meal, and salt was deleted in order to improve the consistency, texture and flavor of this product.

Frankfurters

Franks were reduced in diameter to fit into the pouch carrier but increased in density (through use of leaner meat formulas) which permitted a fill of four franks per pouch.

Ground Beef with Pickle Flavored Sauce

Beef used is specified as Economy Grade plates and chucks in place of Good Grade for the same reasons as noted under Beef Steaks. Tomato paste was used in place of tomato puree and starch; oleoresin paprika, cayenne pepper, cloves, and allspice were added to this product to improve the flavor acceptability and improve appearance and texture. For the same reasons, Worcestershire sauce and mustard flour were eliminated.

Pork Sausage

Sausage links of 4-3/4" to 5" length were used in place of standard sausage links for filling purposes. This reduced the number of links (pieces) from 6 or 8 down to 4 pieces and permitted lengthwise placement in the pouch similar to frankfurters.

Pineapple in Syrup

Crushed pineapple canned in heavy syrup was used in place of fresh frozen pineapple due to objectionable flavors in finished product when using frozen product. The juice from the canned pineapple was used in preparing the 70° Brix solution for this product.

Development of Bench Model Formulas

Bench Model lots of product were prepared and successfully evaluated for pouch laminate testing (see Task C), filler testing (see Task DD), pouch seal testing (see Task E), retort processing data and specifications (see Task EE) and acceptance testing (see Task K). Processing data and specifications for retort temperature, pressures and time were developed under this task and are specified for laboratory tests in the respective Commercial Production Guides. Exact process schedules must be determined by heat penetration studies when the Phase II equipment is available.

Residual Gas Measurements were not performed during Phase I due to lack of equipment available for simulated production and products. The procedure proposed for conducting such test has been developed and is shown in Figure Appendix 3, page 225 as a drawing of the proposed test equipment.

Acceptance Testing of Proposed Commercial Production Guide Products

All 12 products developed in the bench model tests were evaluated using a 10-member sensory acceptance panel and a 9-point hedonic scale. These evaluations are for purposes

of establishing acceptance rating scores to be used as a quality control measure for daily production runs during future phases. The desired minimum average or majority score is 6 or higher. Summarized statistical results of these panel ratings are shown in the section *Specific Results and Conclusions*, Table A-XIII (page 28).

In addition, products 13 through 17 (bakery items) were panel acceptance evaluated as above, and results are shown in Table V-VII (page 48).

All 12 food products were found to be acceptable by our panel evaluation. These final products were also submitted to the U. S. Army Natick Laboratories for evaluation and were found to be acceptable.

TABLE A-I

COMMERCIAL PRODUCTION GUIDE

PRODUCT 1

BEANS IN TOMATO SAUCE

FORMULA	%
Navy Beans U.S. # 1 (Michigan Hand Pick)	50.000
Water	27.254
Tomato Paste (30% Solids)	15.000
Sugar	5.000
Vegetable Oil	1.500
Salt	1.000
Onion Powder	0.170
Garlic Powder	0.020
Cinnamon, Ground	0.015
Clove, Ground	0.015
Allspice, Ground	0.015
Black Pepper, Ground	0.006
Mace, Ground	0.005
	100.000

HANDLING

Dry Navy beans are soaked in 180°F. water for a period of one and a half hours or until the pick-up in weight is approximately 100%. The remaining ingredients are combined into a wet sauce. Foil pouches are filled with two and a half ounces of soaked beans and two and a half ounces of sauce. The total fill weight will be 5 oz ± 1/4 oz. Pouches are vacuum sealed.

PROCESS

The sealed pouches are processed in water in vertical carriers in racks with complete water circulation throughout the cook and with an overriding air pressure of 25 psi. The retort schedule shall be sufficient to provide a sterilization value (F_0) equivalent to 6.0 (40 minutes at 240°F. plus come-up time), followed by 30 minutes chilling time.

TABLE A-II

COMMERCIAL PRODUCTION GUIDE

PRODUCT 2

BEEF LOAF

FORMULA	%
Beef Chucks, ground 3/8" cooked	74.20
Egg Whites, frozen	10.00
Beef Juices	10.00
Cracker Meal (Newly Wed)	5.00
Salt	0.50
Hydrolyzed Vegetable Protein, powdered, (Nestle 4-BE)	0.20
White Pepper	0.10
	100.00

HANDLING

The cracker meal, salt, hydrolyzed vegetable protein, and white pepper are premixed. The dry premix, beef juices, and egg whites are mechanically blended with the beef in the order mentioned. The pouches are filled 5 oz. ± 1/2 oz. and vacuum sealed.

PROCESS

The sealed pouches are processed in water in vertical carriers in racks with complete water circulation throughout the cook and with an overriding air pressure of 25 psi. The retort schedule shall be sufficient to provide a sterilization value (F_0) equivalent to 6.0 (45 minutes at 240°F. plus come-up time), followed by 30 minutes of chilling time.

TABLE A-III

COMMERCIAL PRODUCTION GUIDE

PRODUCT 3

BEEF STEAK

FORMULA & HANDLING

Whole pieces (8 to 10 lb.) of economy rib eye rolls, lip off, are stuffed into #9 casings and into stainless steel molds if necessary. The beef rolls are placed on racks in a smokehouse to be steam-cooked for 2 hours and 15 minutes or until the temperature of the roll reaches an internal temperature of 160°F. (and a shrink of 30 to 35%). Rolls are to be chilled overnight and then trimmed to a 2-5/8" by 5" diameter. Rolls are then cut into steaks (5/8" maximum thickness) and seasoned with a mixture of 49 parts of salt and 1 part of white pepper at a 1/4 level teaspoon (1.33%) per steak. Steaks are placed into pouches with a fill weight of 5 oz. ± 1/2 oz., and vacuum sealed.

PROCESS

The sealed pouches are processed in water in vertical carriers in racks with complete water circulation throughout the cook and with an overriding air pressure of 25 psi. The retort schedule shall be sufficient to provide a sterilization value (F_o) equivalent to 6.0 (40 minutes at 240°F. plus come-up time), followed by 30 minutes chilling time.

TABLE A-IV

COMMERCIAL PRODUCTION GUIDE

PRODUCT 4

BEEF STEW

FORMULA	%
Beef Diced Blanched (3/4" x 3/4" x 3/4")	40.30
Water	26.37
Baby Lima Beans, Frozen	9.28
Potatoes, Fresh Diced (1/2" x 1/2" x 1/2")	9.28
Carrots Diced Frozen (3/8" x 3/8" x 3/8")	7.14
Starch, Miracleer #340 (Staley)	2.20
Tomato Paste (30% Solids)	2.00
Margarine (Swift Allsweet)	1.50
Salt	1.00
Sugar	0.32
Hydrolyzed Vegetable Protein, Liquid (Nestle 4BE)	0.20
Onion Powder	0.20
Pepperoyal (salt base)	0.08
Caramel Color, Dry (FMC)	0.06
Celery Royal (Salt Base)	0.06
Garlic Powder	0.01
	100.00

HANDLING

All dry ingredients are premixed. The water and hydrolyzed vegetable protein are mixed with the tomato paste and melted margarine, and then the dry ingredients are added with rapid agitation. This mixture is heated to 175°F. with agitation. The meat is diced and blanched by dipping in boiling water. This product will be filled in a two-stage operation. The vegetables and gravy mixtures are combined and filled followed by a volumetric filling of the diced, blanched meat. The total fill weight will be 5 oz. ± 1/2 oz. The pouches are vacuum sealed. The breakdown of the finished product should be approximately as follows: Diced Blanched Beef – 2 oz., Mixed Vegetables – 1.25 oz., Gravy – 1.75 oz.

PROCESS

The sealed pouches are processed in water in vertical carriers in racks with complete water circulation throughout the cook and with an overriding air pressure of 25 psi. The retort schedule shall be sufficient to provide a sterilization value (F_0) equivalent to 6.0 (40 minutes at 240°F. plus come-up time), followed by 30 minutes of chilling time.

TABLE A-V

COMMERCIAL PRODUCTION GUIDE

PRODUCT 5

BEEF SLICES IN BBQ SAUCE

FORMULA (BBQ SAUCE)	%
Tomato Paste (30% Solids)	36.75
Water	30.50
Brown Sugar	15.50
Vinegar – 100-Grain	4.50
Vegetable Oil	3.40
Salt	2.60
Worcestershire Sauce (Sexton)	2.50
Onion Powder	1.30
Starch, Instant Clearjel (National)	1.00
Mustard, Ground	0.75
Hot Sauce	0.50
Celery Powder	0.20
Cloves, Ground	0.13
Allspice, Ground	0.13
White Pepper	0.09
Cayenne Pepper	0.08
Garlic Powder	0.07
	100.00

HANDLING

The Instant Clearjel Starch is mixed with water and then combined with all the remaining ingredients for the BBQ sauce mixture. Whole pieces (8 to 10 lb) economy ribeye rolls, lip off, are stuffed into #9 casings. The beef rolls are placed on racks in a smokehouse to be steam-cooked for one hour and 20 minutes or until the temperature of the meat rolls reached an internal temperature of 140° to 150°F (and a shrink of 20% to 25%). Rolls are to be chilled overnight and then trimmed to a 2 5/8 x 5" diameter. The rolls will be sliced so that two slices weigh approximately 2 3/4 oz. The pouches will be filled with two slices of meat weighing 2 3/4 oz. and BBQ sauce weighing 2 1/4 oz. The total fill weight shall be 5 ± 1/2 oz.

PROCESS

The sealed pouches are processed in water in vertical carriers in racks with complete water circulation throughout the cook and with an overriding air pressure of 25 psi. The retort schedule shall be sufficient to provide a sterilization value (F_0) equivalent to 6.0 (35 minutes at 240°F plus come-up time), followed by 30 minutes chilling time.

TABLE A-VI

COMMERCIAL PRODUCTION GUIDE

PRODUCT 6

CHICKEN ALA KING

FORMULA	%
Chicken Broth	38.00
Chicken, Fowl, Cooked Diced Frozen (3/8" x 3/8" x 1/2")	30.00
Whole Milk	14.20
Green Peas, Frozen	5.00
Pimentos, Canned	2.50
Wheat Flour	2.10
Rice Flour	2.10
Mushrooms, Sliced, Canned	2.10
Chicken Fat	2.00
Chicken Flavoring (Lipton)	0.70
Salt	0.61
Monosodium Glutamate	0.35
Carboxy Methyl Cellulose	0.28
Celery Salt	0.03
White Pepper	0.03
	100.00

HANDLING

All dry ingredients are premixed. All broth, milk, oil, and fat are mixed and the dry ingredients are added with rapid agitation. This mixture is heated to 175°F. and all other ingredients are added. The pouches are filled with 5 ± 1/2 oz. of total mix, and vacuum sealed.

PROCESS

The sealed pouches are processed in water in vertical carriers in racks with complete water circulation throughout the cook and with an overriding air pressure of 25 psi. The retort schedule shall be sufficient to provide a sterilization value (F_O) equivalent to 6.0 (30 minutes at 240°F plus come-up time) followed by 30 minutes of chilling time.

TABLE A-VII

COMMERCIAL PRODUCTION GUIDE

PRODUCT 7

CHICKEN LOAF

FORMULA	%
Chicken Fowl Frozen, (Natural Proportion) cooked, diced 3/8"	66.18
Egg whites, frozen	12.50
Chicken broth (3.5% solids) (Swift)	10.00
Chicken fat	5.00
Cracker meal (Newly Wed)	5.00
Salt	0.50
Gelatin, 275 bloom, dry	0.50
Monosodium Glutamate	0.20
White pepper	0.12
	100.00

HANDLING

The cracker meal, salt, monosodium glutamate, and white pepper are premixed. The gelatin is added to the chicken broth. With the use of mechanical mixing, the dry premix, chicken broth-gelatin mix, egg whites, and chicken fat are added to the chicken in the order mentioned. The pouches are filled with 5 ± 1/2 oz., and vacuum sealed.

PROCESS:

The sealed pouches are processed in water in vertical carriers in racks with complete water circulation throughout the cook and with an overriding air pressure of 25 psi. The retort schedule shall be sufficient to provide a sterilization value (F_O) equivalent to 6.0 (35 minutes at 240°F plus come-up time) followed by 30 minutes chilling time.

TABLE A-VIII

COMMERCIAL PRODUCTION GUIDE

PRODUCT 8

HAM AND CHICKEN LOAF

FORMULA	%
Chicken, Fowl (Natural Proportion) Frozen, Cooked, Diced 3/8"	39.84
Ham, Fully cooked, diced 3/8"	39.84
Egg whites, frozen	10.00
Chicken broth	5.00
Cracker meal (Newly Wed)	5.00
Monosodium Glutamate	0.20
White pepper	0.12
	100.00

HANDLING

The cracker meal, monosodium glutamate, and white pepper are premixed. With the use of mechanical mixing, the dry premix, chicken broth, and egg whites are added to the blended chicken and ham in the order mentioned. The pouches are filled with 5 ± 1/2 oz., and vacuum sealed.

PROCESS

The sealed pouches are processed in water in vertical carriers in racks with complete water circulation throughout the cook and with an overriding air pressure of 25 psi. The retort schedule shall be sufficient to provide a sterilization value (F_O) equivalent to 6.0 (40 minutes at 240°F plus come-up time) followed by 30 minutes chilling time.

TABLE A-IX

COMMERCIAL PRODUCTION GUIDE

PRODUCT 9

FRANKFURTERS

FORMULA	%
*Beef, Cow	22.6085
*Beef, Plates or Flanks	22.6085
*Pork, Regulars (50/50)	22.6085
*Pork, Leans (80/20)	22.6085
Moisture (Ice)	5.4260
Salt	2.7130
Sugar	0.9043
Frank Seasoning (Swift HRI)	0.4522
Sodium Erythrobate	0.0494
Sodium Nitrite	0.0141
Garlic Powder	0.0070
	100.0000

*Formulation adjusts to give a 25% fat finished product

HANDLING

Beef is ground through a 1/8" plate. Pork is ground through a 1" plate. All meat is combined with the spice, cure, and ice for chopping in the cut-mix using a maximum vacuum. The mix is then emulsified and stuffed into a #22 artificial casing and linked into a 5 1/4" maximum length frank. The franks are held in a smokehouse (heavy smoke) for 2 1/2 hours or until an internal temperature of 160°F is reached. Franks are chilled with a water spray and then held overnight in a 36°–38° cooler. The casings are removed and four franks having a 5" maximum length are stuffed into the pouch with a fill weight of 5 ± 1/2 oz. The filled pouches are vacuum sealed.

PROCESS

The sealed pouches are processed in water in vertical carriers in racks with complete water circulation throughout the cook and with an overriding air pressure of 25 psi. The retort schedule shall be sufficient to provide a sterilization value (F_O) equivalent to 6.0 (40 minutes at 240°F. plus come-up time) followed by 30 minutes chilling time.

TABLE A-X

COMMERCIAL PRODUCTION GUIDE

PRODUCT 10

GROUND BEEF WITH PICKLE FLAVORED SAUCE

FORMULA	%
Beef, cooked, ground (25% Plates – 75% Chucks)	50.000
Water	23.925
Tomato paste (30% solids)	15.500
Vinegar – 100-Grain	3.000
Sugar	3.000
Onion powder	2.000
Salt	1.500
Starch, Instant Clearjel (National)	1.000
Oleoresin Paprika (80,000 units)	0.050
Cayenne pepper	0.010
Cloves, ground	0.009
Allspice, ground	0.006
	100.000

HANDLING

Instant Clearjel starch is mixed with water and then combined with all the remaining indgredients for the sauce mixture. The raw beef is ground through a 1/2" plate followed by another grind through a 5/16" plate. The ground meat is then braised for a cooking yield of 70%-75%. The cooked meat and sauce are combined and filled into the foil pouches with a filling weight of 5 ± 1/2 oz. and vacuum sealed.

PROCESS

The sealed pouches are processed in water in vertical carriers in racks with complete water circulation throughout the cook and with an overriding air pressure of 25 psi. The retort schedule shall be sufficient to provide a sterilization value (F_O) equivalent to 6.0 (40 minutes at 240°F plus come-up time) followed by 30 minutes chilling time.

TABLE A-XI

COMMERCIAL PRODUCTION GUIDE

PRODUCT 11

PORK SAUSAGE

FORMULA	%
Pork, regular trimmings	45.5340
Pork, special lean trimmings	31.6740
Beef, cow meat	13.6600
Water	5.6937
Salt	1.7050
Sugar (Sucrose)	0.9120
White Pepper	0.4010
Sage	0.2200
Swift "A" Cure	0.0003
	100.0000

HANDLING

Length of the sausage will be increased to a length of 4 3/4 to 5" and have a weight of one ounce each. Four sausages will be stuffed into the pouch with a fill weight of 4 ± 1/4 oz. NOTE: Fill will be lengthwise rather than crosswise in the package (i.e. Frankfurters). Filled pouches will be vacuum sealed.

PROCESS

The sealed pouches are processed in water in vertical carriers in racks with complete water circulation throughout the cook and with an overriding air pressure of 25 psi. The retort schedule shall be sufficient to provide a sterilization value (F_0) equivalent to 6.0 (40 minutes at 240°F plus come-up time) followed by 30 minutes chilling time.

TABLE A-XII

COMMERCIAL PRODUCTION GUIDE

PRODUCT 12

PINEAPPLE IN SYRUP

FORMULA	%
Crushed Pineapple (Heavy Syrup)	77.77
Sugar Solution (70° Brix)	22.23
	100.00

HANDLING

Canned, crushed pineapple packed in very heavy syrup (24° Brix) is drained for two minutes on a No. 8 sieve. A 70° Brix syrup solution is prepared by blending the necessary amounts of sugar and water together with the drained pineapple juice. The above percentages of crushed, drained pineapple and 70° Brix syrup are blended and filled as 4.5 ± 1/4 oz. total per pouch. The pH of the blended product shall be 4.0 or less (adjustment shall be made with Food Grade Citric Acid, if necessary). The filled pouches are vacuum sealed.

PROCESS

Hold filled pouches in 200° to 205°F. water for five minutes or until the internal product temperature is at least 195°F.

4. Acceptance testing of final products.

Table A-XIII represents all potential pouch foods (except bakery items) thus far screened through Sensory Evaluation along with the number of individual panelists scoring above a 6.00 acceptance level (by item). All products were evaluated by a 10-member panel using the nine-point word hedonic scale, which represents a range of 1.00, or dislike extremely, to 9.00, or like extremely. A rating of 5 is neither like nor dislike.

TABLE A-XIII

Sensory Evaluation Ratings Summary

Accepted Products 1-12

Product No.	Item	Mean Acceptability	No. of Judges	Score
1	Beans in Tomato Sauce	6.70	5	8
			2	7
2	Beef Loaf	6.60	3	8
			4	7
			1	6
3	Beef Steak	7.30	4	8
			5	7
			1	6
4	Beef Stew	7.80	2	9
			5	8
			2	7
			1	6
5	Beef Slices in BBQ Sauce	6.90	4	8
			3	7
			1	6
6	Chicken Ala King	7.50	7	8
			2	7
7	Chicken Loaf	6.20	1	9
			2	8
			3	7
			1	6
8	Ham and Chicken Loaf	7.00	1	9
			3	8
			3	7
			1	6
9	Franks	7.40	5	8
			4	7
			1	6
10	Ground Beef with Pickle Flavored Sauce	6.30	5	8
			1	7
			1	6
11	Pork Sausage	7.22	2	9
			1	8
			5	7
12	Pineapple in Syrup	7.00	1	9
			3	8
			2	7
			3	6

Task B Food Preparation and Processing Concepts – Products 13 through 17

Proposed guideline formulas were revised and approved by the U. S. Army Natick Laboratories, acceptance tested and scored by a ten-member sensory panel using a 9-point hedonic scale. Revised guideline formulas were developed and used in filling (Task DD). Commercial production guides were prepared for the five bakery items and approved. They are considered commercially feasible for use in thermoprocessing bakery products packaged in flexible pouches. We recommend that these commercial production guides be used in future phases of this contract.

Bakery items require close control of formulation, preparation, and processing since three functions – leavening, setting of structure, and sterilization – must occur. A review of prior art found that a major portion of the successful effort had been conducted using steam/air processes. Our goal was to duplicate or better these efforts using a water retort. This would then make one system compatible to the whole line of products.

Pound Cake was selected as a model. A major portion of the results from pound cake development was applied to other bakery items eliminating duplication of effort. A major portion of the research work in Phase I was the development of a formula and process for pound cake that could be manufactured repeatedly and would yield a readily identifiable end product. As a result of this research, we have developed formulas and process criteria for each of the bakery items. In general, each of the cakes received high scores from sensory paneling, but bread was below the desired acceptance criteria.

A discussion of the formula changes, batter blending procedures, package filling and sealing requirements, and thermal processing follows.

Formula Changes

The basic changes to the proposed guideline formulas were made to produce a conventional baked cake structure and texture in a water retort. In general, the changes were related to the leavening system and its ability to overcome water head and temperature equilibrium pressures in the retort while building the most desirable product structure. It was also necessary to "build" into the particular formula some desirable flavor and color characteristics of conventional baked goods. Commercial production guides are shown in Tables B-II through B-VI, which are: B-II – Pound Cake Formula, B-III – Chocolate Nut Cake Formula, B-IV – Fruit Cake Formula, B-V – Orange Nut Cake Formula, B-VI – Bread Formula, pages 38 through 47.

Formula Preparation

Tables B-II through B-VI show the mixing and blending procedures for preparation of the formula prior to transfer to the package fillers. Each product formula is treated individually rather than considering basic cake batters or basic fruit cake batters. The blending instructions also indicate the use of a 1000-pound Readco Sigma mixer. It is possible, however, to utilize two large Hobart mixers on a semi-continuous basis.

General Filling and Packaging Considerations

A series of experiments demonstrated that time is an important factor in the accurate control of fill weights and control of the overriding pressure in the hydroclave. The "limits" with regard to time differential between blending and heat processing cannot be accurately set until a production unit is on stream. The experimental data indicates that the batter density changes significantly after three hours at room temperature. Refrigeration of the batter greatly retards the density change. In the event of a machine failure or other process delay, salvage of cake products is possible through refrigeration. Vacuum packaging is not necessary in packaging the bakery items. It is necessary to remove residual gas from the product by either a mechanical method or a slight vacuum prior to sealing so that each package achieves approximately the same internal pressure during heat processing. Table B-I shows an experiment designed to determine the effects of normal production tolerances.

Figure B-I is a composite graph showing the extremes of the results from this experiment. The most significant information from this experiment is the 8 psi difference in pouch pressure at the extremes. This experiment supported the conclusion that a single program for retort overriding air pressure was not possible and that a controller would be required that would automatically control to the conditions of the particular batch in process.

Thermoprocessing

Considerable experimentation to determine the criteria for thermoprocessing has been completed and processing specifications have been established. It is necessary to conduct a final experiment on production equipment to confirm the established process criteria (come-up time, hold time, differential pressure controls, etc.). A major portion of the process study effort was conducted for the purpose of determining an air override pressure program for each of the bakery items so that a control cam could be manufactured for controlling overriding air pressure in the retort. It is necessary to control the retort pressure so that the pressure inside the pouches being processed is slightly higher than the retort pressure, including the water head pressure at the deepest process point. This creates a condition where proper product textures can be achieved. It is also necessary to maintain the pressure differential as low as possible to protect the integrity of the pouches. When proper control is achieved, the products expand within the confines of the pouch in the pouch carrier, creating a uniform shape and density without excess stress on the pouch seals.

TABLE B-I

PROCESS EXPERIMENT DESIGN – POUND CAKE

This experiment was designed to determine the overall effect of five normal variables expected during production. The variables studied were residual gas in package, product net weight, rate of temperature rise, percent of soda, and percent of sodium aluminum phosphate. This was a 33-run experiment which was condensed to 8 by grouping the randomized runs so that a set of four could be run together. All other variables were fixed.

Run Number	Vacuum mm/hg	Net Weight Grams	Temperature Rise–°F/Min	Percent Soda	Percent Sodium Aluminum Phosphate
5	0	98	8	0.50	0.50
8	600	102	8	0.50	0.50
7	0	102	8	0.50	0.50
6	600	98	8	0.50	0.50
15	0	102	8	0.64	0.50
16	600	102	8	0.64	0.50
13	0	98	8	0.64	0.50
14	600	98	8	0.64	0.50
22	600	98	8	0.50	0.64
24	600	102	8	0.50	0.64
23	0	102	8	0.50	0.64
21	0	98	8	0.50	0.64
31	0	102	8	0.64	0.64
30	600	98	8	0.64	0.64
29	0	98	8	0.64	0.64
32	600	102	8	0.64	0.64
1	0	98	5	0.50	0.50
2	600	98	5	0.50	0.50
3	0	102	5	0.50	0.50
4	600	102	5	0.50	0.50
10	600	98	5	0.64	0.50
9	0	98	5	0.64	0.50
12	600	102	5	0.64	0.50
11	0	102	5	0.64	0.50
19	0	102	5	0.50	0.64
18	600	98	5	0.50	0.64
17	0	98	5	0.50	0.64
20	600	102	5	0.50	0.64
25	0	98	5	0.64	0.64
28	600	102	5	0.64	0.64
27	0	102	5	0.64	0.64
26	600	98	5	0.64	0.64
33	300	100	6.5	0.57	0.57

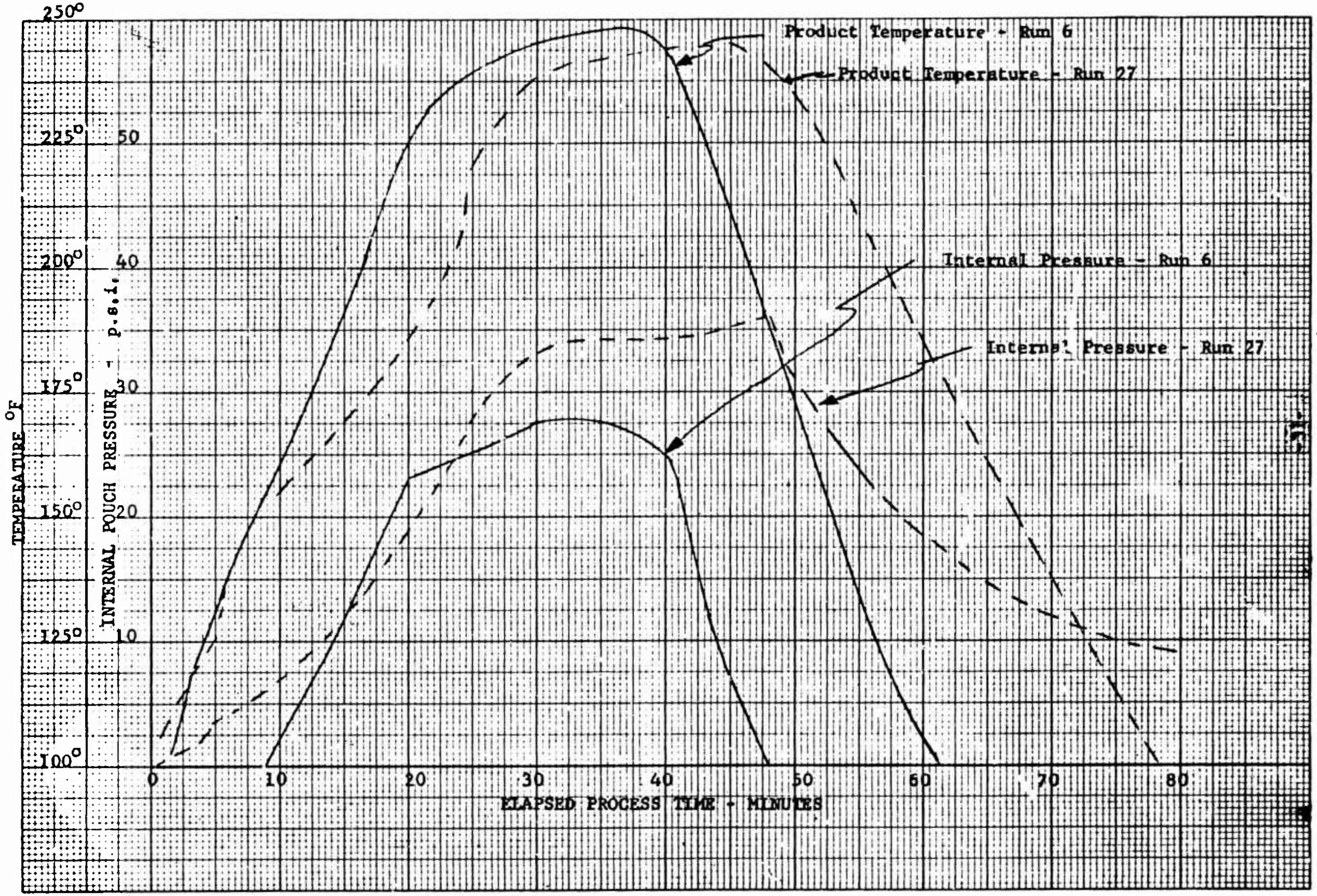


FIGURE B-1
EXTREMES FROM PROCESS EXPERIMENT (POUND CAKE)

Figure B-2 is representative of the product shape achieved through proper retort pressure control. The process study experiments showed that excessive differences in pouch pressure occurred from batch to batch. Follow up experiments showed that variations in relative humidity, ambient temperature, mixing time, mixing speed, and mix water temperature significantly affected the final pouch pressure. To accurately measure these differences and as a first step in developing automatic retort pressure control, a set of four pressure-tight cans were designed. Figure B-3 shows the configuration of this control can with the pressure sensing tap. They were built geometrically similar in shape to a fully expanded pouch (when contained in a pouch rack). Heat penetration studies showed that heat transfer differences (between the cans and pouches) were negligible and that internal conditions were essentially the same. The cans were located near the periphery of the retort and connected to an exterior gage by a 1/16" capillary tube which was kept as short as possible to keep residual air at a minimum. Bench trial runs, where an operator manually controlled the retort pressure to maintain a 0 to 2 psig pressure differential between a gauge indicating the control can pressure and a gauge indicating retort pressure, yielded a superior product which was well shaped and evenly distributed in the package. It was concluded that a differential pressure control device, using a pressure-tight can and the retort as the two units being sensed, would effectively overcome the differing batch-to-batch pressure differences and that the need for stringent controls on the variables affecting the final pressure could be eliminated. This automatic pressure control device was designed and built. Figure B-4 shows the operational characteristics of this unit.

The features of the Automatic Control Device are:

(1) Pressure Tight Control Can
(2) Pressure Vessel (Retort)
(3) Control Can Pressure Sensing Capillary
(4) Pressure Vessel Pressure Sensing Capillary
(5) Differential Pressure Transmitter (Honeywell, Model No. Y29212)
(6) Auxiliary Pressure Recorder (Retort)
(7) Temperature/Pressure Controller (Taylor, Model No. 121RW1250) with pressure control range of 0 to 50 psi
(8) Air Pressure Control Valve (Taylor Model No. D100NF1220-532) Normally closed operates from 9 to 15 psi signal
(9) Air Exhaust Control Valve (Taylor Model No. D100NF1220-532) Normally open, operates from 3 to 9 psi signal

Since the internal conditions of the pressure tight control can (1) have been shown to be identical to the conditions of the pouches in process, the pressure control strategy is to simultaneously sense the control can (1) pressure and the Retort (2) pressure using capillaries (3) and (4) connected to the differential pressure transmitter (5). Capillary (3) is connected to the high side of transmitter (5) and capillary (4) is connected to the low side. The retort (2) pressure is constantly recorded by the pressure recorder (6).

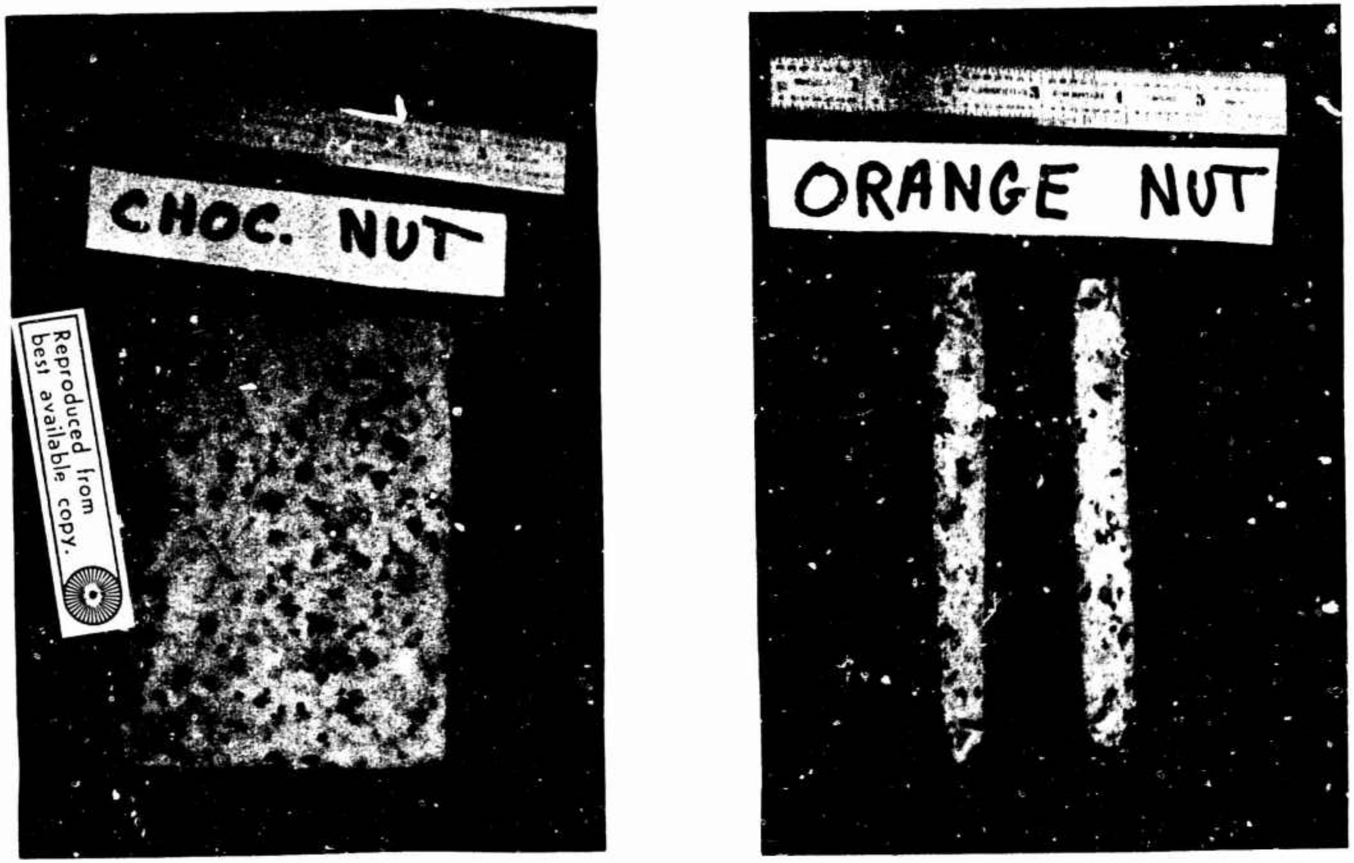


FIGURE B-2 PRODUCT SHAPE

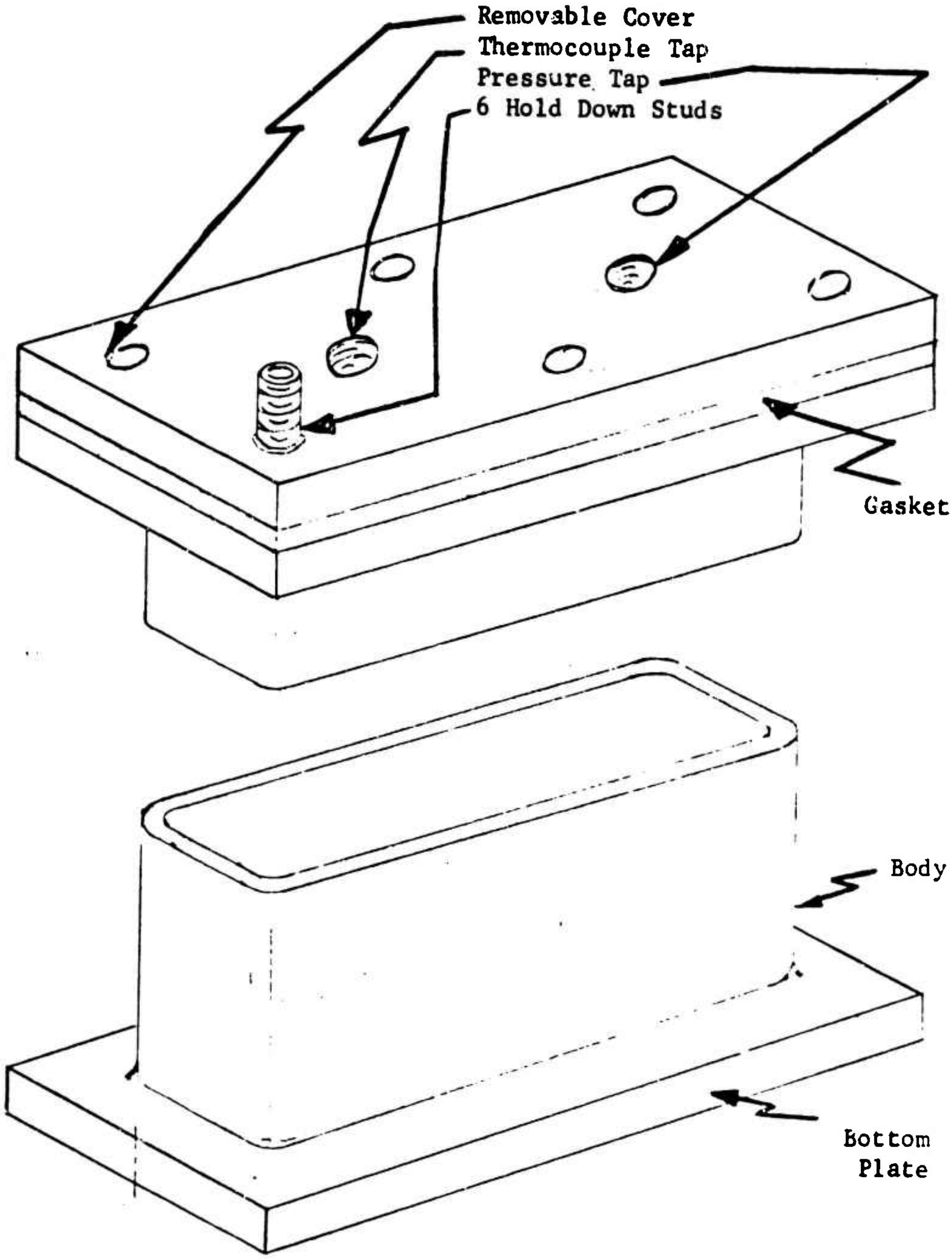
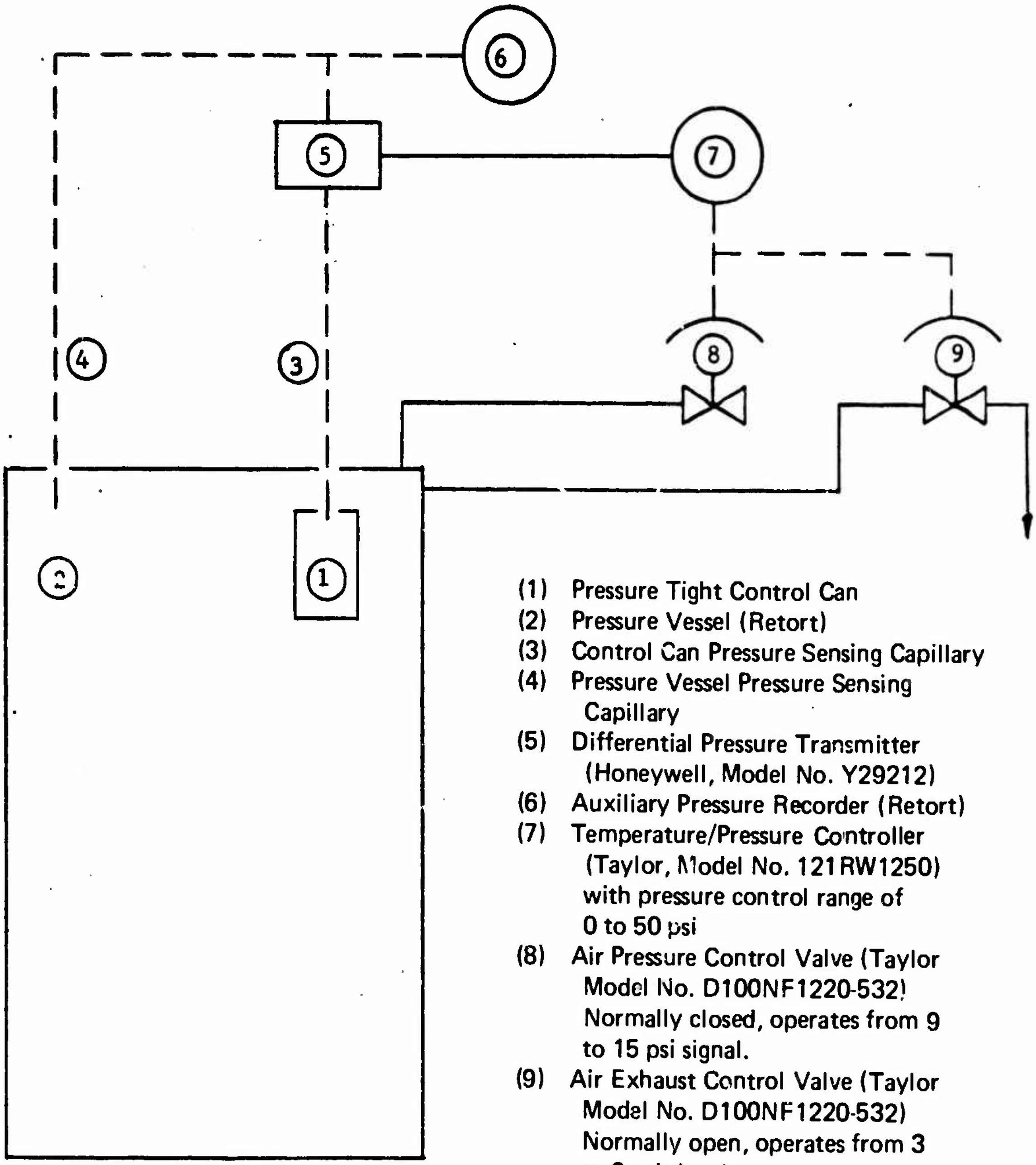


FIGURE B-3 PRESSURE TIGHT CONTROL CAN



(1) Pressure Tight Control Can
(2) Pressure Vessel (Retort)
(3) Control Can Pressure Sensing Capillary
(4) Pressure Vessel Pressure Sensing Capillary
(5) Differential Pressure Transmitter (Honeywell, Model No. Y29212)
(6) Auxiliary Pressure Recorder (Retort)
(7) Temperature/Pressure Controller (Taylor, Model No. 121RW1250) with pressure control range of 0 to 50 psi
(8) Air Pressure Control Valve (Taylor Model No. D100NF1220-532) Normally closed, operates from 9 to 15 psi signal.
(9) Air Exhaust Control Valve (Taylor Model No. D100NF1220-532) Normally open, operates from 3 to 9 psi signal.

FIGURE B-4 RETORT PRESSURE CONTROL

The differential pressure transmitter (5) is pre-set to the desired pressure difference. When the retort (2) pressure is the same as the pressure in the control can (1); e.g., at the beginning of the cycle, or in the early stage of temperature come-up, the differential pressure transmitter (5) sends a weak (3 psi) signal to the pressure controller (7). The air pressure control valve (8) remains closed and the air exhaust control valve (9) remains open. As the control can (1) pressure rises and approaches the desired differential pressure, the differential pressure transmitter (5) sends a strong signal; e.g., 9 psi at the set point. The exhaust control valve (9) which operates over its full range at signal pressures between 3 and 9 psi, fully closes. As the pressure differential tends to exceed the set point, a stronger signal is transmitted to the pressure controller (7) and the air pressure control valve (8) opens. This valve operates over its full range at signal pressures between 9 and 15 psi. As the pressure differential tends to fall below the set point, a weaker signal is transmitted to the pressure controller (7), the air pressure control valve (8) closes, and the exhaust control valve (9) opens. The proportional band control and valve actions are shown in Figure B-5.

A source of concern during the processing studies in this phase was that the bakery items tended to float out of the pouch holders. This caused the cakes to mushroom at the top of the package. A hold-down bar designed to fit a retort rack was supplied by Continental Can and a trial retort run was made with pound cake. The hold-down bars performed satisfactorily, and we recommend that they be used during future phases.

Sensory panel tasting was conducted on each of the five bakery items. The individual panelist scores for these items are found in Table B-VII, page 48.

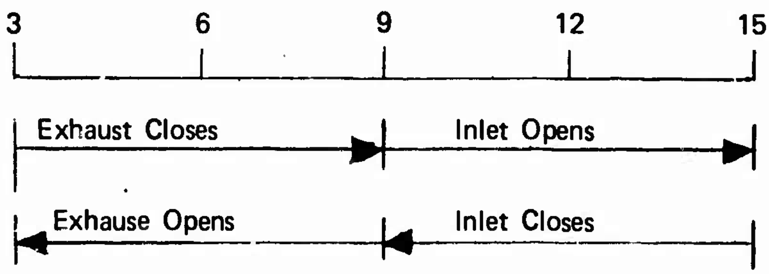


FIGURE B-5 PROPORTIONAL BAND AND VALVE CONTROL ACTION

TABLE B-II

COMMERCIAL PRODUCTION GUIDE

PRODUCT 13

POUND CAKE

FORMULA	%
Salt	0.830
Flour (Snosheen Cake)	29.030
Whole Eggs	13.390
Sugar, Granulated	36.139
Shortening, Hydrogenated Vegetable	14.060
Sodium Bicarbonate	0.570
Sodium Aluminum Phosphate	0.570
Gum Arabic	0.190
Imitation Vanilla Sugar (10-fold strength)	0.190
Imitation Butter Flavor Powder	0.001
Yellow Color Premix (0.2% dye)	0.670
Imitation Lemon Flavor Powder (0.5-fold oil strength)	0.060
Water	4.300
	100.000

PREPARATION OF BATTER

In preparing pound cake batter, either a Readco (jacketed Sigma blade) mixer or two floor model Hobart mixers may be used. If a Readco is used (preferred method), cold water should be circulated through the jacket while blending to retard bench action of leavening system. If Hobart floor model mixers are used, smaller batches on a semicontinuous basis are required.

1. Blend all dry ingredients thoroughly using slow speed on mixer. (Assure no lumps in either leavening) 5 to 10 minutes.

2. Blend in shortening gradually. Mix at medium speed until well blended. Five minutes.

3. In a separate blender (A200 Hobart w/wire whip) blend the water and fresh eggs.

4. Add the water and eggs to the mix and blend batter thoroughly at a medium speed. Five minutes.

5. Batter may be transferred to filler by pump or by hand.

PACKAGING

1. The pound cake batter is filled in the foil pouches using a bottom fill technique at 100 grams, ± 2 grams.

2. Vacuum sealing is not required for this product, but residual air should be removed by a mechanical means prior to sealing. In lieu of such mechanical means, a very slight vacuum is acceptable.

3. The filled pouches are to be top sealed.

4. All packaging should be accomplished within two hours after blending.

THERMOPROCESSING

1. Thermoprocessing of pound cake should begin no later than three hours after batter is blended unless batter or packages are held at refrigerated conditions.

2. When approximately half the pouches from a batch have been filled, the pressure control can should be filled with product (100 grams) and the residual air evacuated through the pressure tap and shutoff valve. The differential pressure transmitter should be set at 2 psi allowing the internal package pressure to exceed the overriding (retort) air pressure throughout the process cycle.

3. With the filled pouches at room temperature, the processing water temperature at the beginning of a retort run should be at 80° ± 5°F and the rate of temperature rise should be set at 8°F/minute consistent within ± 2°F throughout the retort.

4. The processing unit should be maintained at 250°F for 20 minutes with temperatures throughout the unit consistent to ± 1°F.

5. The unit cool-down rate should be at 8°F/minute with temperatures throughout being consistent to ± 2°F. Products may be removed when water temperature falls below 100°F.

6. The above processing profile yielded F_0 values of greater than 6 during product development.

TABLE B-III

COMMERCIAL PRODUCTION GUIDE

PRODUCT 14

CHOCOLATE NUT CAKE

FORMULA	%
Salt	0.594
Flour (Snosheen Cake)	21.308
Whole Eggs	9.587
Sugar Granulated	25.876
Shortening, Hydrogenated Vegetable	10.067
Sodium Bicarbonate	0.408
Sodium Aluminum Phosphate	0.408
Gum Arabic	0.136
Imitation Vanilla Sugar (10-fold strength)	0.136
Imitation Butter Flavor Powder	0.001
Water	3.079
Chocolate Drops (10,000 count)	14.200
Pecan Pieces (coated with acetylated monoglycerides)	14.200
	100.000

PREPARATION OF BATTER

In preparing chocolate nut cake batter, either a Readco (jacketed Sigma blade) mixer or two floor model Hobart mixers may be used. If a Readco is used (preferred method), cold water should be circulated through the jacket while blending to retard bench action of leavening system. If Hobart floor model mixers are used, smaller batches on a semicontinuous basis are required.

1. Blend all dry ingredients except chocolate drops and nuts thoroughly using slow speed on mixer. (Assure no lumps in either leavening.) 5 to 10 minutes.

2. Blend in shortening gradually. Mix at medium speed until well blended. 5 minutes.

3. In a separate blender (A200 Hobart w/wire whip), blend the water and fresh eggs.

4. Add the water and eggs to the mix and blend batter thoroughly at medium speed. 5 minutes.

5. Add chocolate pieces and nuts to mix and blend. Slow speed about 15 seconds.

6. Batter may be transferred to filler by pump or by hand.

PACKAGING

1. The chocolate nut cake batter is filled in the foil pouches using a bottom fill technique at 113 grams, ± [illegible] grams.

2. Vacuum sealing is not required for this product, but residual air should be removed by a mechanical means prior to sealing. In lieu of such mechanical means a very slight vacuum is acceptable.

3. The filled pouches are to be top sealed.

4. All packaging should be accomplished within two hours after blending.

5. Minimum attrition of the batter in handling and filling is important to prevent discoloration and loss of discrete particles due to breaking of chocolate or nut meats.

THERMOPROCESSING

1. Thermoprocessing of chocolate nut cake should begin no later than three hours after batter is blended unless batter or packages are held at refrigerated conditions.

2. When approximately half the pouches from a batch have been filled, the pressure control can should be filled with product (113 grams) and the residual air evacuated through the pressure tap and shutoff valve. The differential pressure transmitter should be set at 2 psi allowing the internal package pressure to exceed the overriding (retort) air pressure throughout the process cycle.

3. With the filled pouches at room temperature, the processing water temperature at the beginning of a retort run should be at 80°F ± 5°F and the rate of temperature rise should be set at 8°F/minute consistent within ± 2°F throughout the retort.

4. The processing unit should be maintained at 250°F for 20 minutes with temperatures throughout the unit consistent to ± 1°F.

5. The unit cool-down rate should be at 8°F/minute with temperatures throughout being consistent to ± 2°F. Products may be removed when water temperature falls below 100°F.

6. The above processing profile yielded F_0 values of greater than 6 during product development.

TABLE B-IV

COMMERCIAL PRODUCTION GUIDE

PRODUCT 15

ORANGE NUT CAKE

FORMULA	%
Salt	0.548
Flour (Snosheen Cake)	19.800
Whole Eggs	8.850
Sugar, Granulated	23.890
Shortening, Hydrogenated Vegetable	9.293
Sodium Bicarbonate	0.376
Sodium Aluminum Phosphate	0.376
Gum Arabic	0.125
Water	2.842
Glaced Orange Peel (Double Diced)	22.900
Pecan Pieces (coated with Acetylated Monoglycerides)	11.000
	100.000

PREPARATION OF BATTER

In preparing orange nut cake batter, either a Readco (jacketed Sigma blade) mixer or two floor model Hobart mixers may be used. If a Readco is used (preferred method), cold water should be circulated through the jacket while blending to retard bench action of leavening system. If Hobart floor model mixers are used, smaller batches on a semicontinuous basis are required.

1. Blend all dry ingredients except nuts and orange peel thoroughly using slow speed on mixer. (Assure no lumps in either leavening.) 5 to 10 minutes.

2. Blend in shortening gradually. Mix at medium speed until well blended. 5 minutes.

3. In a separate blender (A200 Hobart w/wire whip) blend the water and fresh eggs.

4. Add the water and eggs to the mix and blend batter thoroughly at medium speed. 5 minutes.

5. Add orange peel and nuts. Blend at slow speed for 30 seconds.

6. Batter may be transferred to filler by pump or by hand.

PACKAGING

1. The orange nut cake batter is filled in the foil pouches using a bottom fill technique at 113 grams, ± 2 grams.

2. Vacuum sealing is not required for this product, but residual air should be removed by a mechanical means prior to sealing. In lieu of such mechanical means, a very slight vacuum is acceptable.

3. The filled pouches are to be top sealed.

4. All packaging should be accomplished within two hours after blending.

5. Minimum attrition of the batter in handling and filling is important to prevent loss of discrete particles of nut meats and orange peel.

THERMOPROCESSING

1. Thermoprocessing of orange nut cake should begin no later than three hours after batter is blended unless batter or packages are held at refrigerated conditions.

2. When approximately half the pouches from a batch have been filled, the pressure control can should be filled with product (113 grams) and the residual air evacuated through the pressure tap and shutoff valve. The differential pressure transmitter should be set at 2 psi allowing the internal package pressure to exceed the overriding (retort) air pressure throughout the process cycle.

3. With the filled pouches at room temperature, the processing water temperature at the beginning of a retort run should be at 80°F ± 5°F and the rate of temperature rise should be set at 8°F/minute consistent within ± 2°F throughout the retort.

4. The processing unit should be maintained at 250°F for 20 minutes with temperatures throughout the unit consistent to ± 1°F.

5. The unit cool-down rate should be at 8°F/minute with temperatures throughout being consistent to ± 2°F. Products may be removed when water temperature falls below 100°F.

6. The above processing profile yielded F_0 values of greater than 6 during product development.

TABLE B-V

COMMERCIAL PRODUCTION GUIDE

PRODUCT 16

FRUIT CAKE

FORMULA	%
Salt	.433
Flour (Snosheen Cake)	15.529
Whole Eggs	6.988
Sugar, Granulated	18.926
Shortening, Hydrogenated Vegetable	7.337
Sodium Bicarbonate	0.297
Sodium Aluminum Phosphate	0.297
Gum Arabic	0.099
Imitation Lemon Flavor Powder (0.5-fold oil strength)	0.031
Ground Cloves	0.005
Ground Nutmeg	0.005
Ground Cinnamon	0.010
Water	2.243
Pecan Pieces (coated with Acetylated Monoglycerides)	13.500
Glaced Red Cherry Pieces	10.200
Glaced Pineapple Dices	8.600
Golden Seedless Raisins	15.500
	100.000

PREPARATION OF BATTER

In preparing fruit cake batter, either a Readco (jacketed Sigma blade) mixer or two floor model Hobart mixers may be used. If a Readco is used (preferred method), cold water should be circulated through the jacket while blending to retard bench action of leavening system. If Hobart floor model mixers are used, smaller batches on a semicontinuous basis are required.

1. Blend all dry ingredients except fruit and nut pieces thoroughly using slow speed on mixer. (Assure no lumps in either leavening.) 5 to 10 minutes.

2. Blend in shortening gradually. Mix at medium speed until well blended. 5 minutes.

3. In a separate blender (A200 Hobart w/wire whip), blend the water and fresh eggs.

4. Add the water and eggs to the mix and blend batter thoroughly at medium speed. 5 minutes.

5. Add fruit & nuts to mix and blend at slow speed for 1 minute.

6. Batter may be transferred to filler by pump or by hand.

PACKAGING

1. The fruit cake batter is filled in the foil pouches using a bottom fill technique at 120 grams, ± 2 grams.

2. Vacuum sealing is not required for this product, but residual air should be removed by a mechanical means prior to sealing. In lieu of such mechanical means, a very slight vacuum is acceptable.

3. The filled pouches are to be top sealed.

4. All packaging should be accomplished within two hours after blending.

5. Minimum attrition of the batter in handling and filling is important to prevent loss of discrete pieces of fruits and nuts.

THERMOPROCESSING

1. Thermoprocessing of fruit cake should begin no later than three hours after batter is blended unless batter or packages are held at refrigerated conditions.

2. When approximately half the pouches from a batch have been filled, the pressure control can should be filled with product (120 grams) and the residual air evacuated through the pressure tap and shutoff valve. The differential pressure transmitter should be set at 2 psi allowing the internal package pressure to exceed the overriding (retort) pressure throughout the process cycle.

3. With the filled pouches at room temperature, the processing water temperature at the beginning of a retort run should be at 80°F ± 5°F and the rate of temperature rise should be set at 8°F/minute consistent within ± 2°F throughout the retort.

4. The processing unit should be maintained at 250°F or 20 minutes with temperatures throughout the unit consistent to ± 1°F.

5. The unit cool down rate should be at 8°F/minute with temperatures throughout being consistent to ± 2°F. Products may be removed when water temperature falls below 100°F.

6. The above processing profile yielded F_o values of greater than 6 during product development.

TABLE B-VI

COMMERCIAL PRODUCTION GUIDE

PRODUCT 17

BREAD

FORMULA	%
Flour	43.660
Shortening	8.000
Sodium Aluminum Phosphate	0.970
Sodium Bicarbonate	0.970
Sodium Stearyl Fumerate	0.900
Water	33.000
Salt	0.500
Sugar	12.000
	100.000

PREPARATION OF DOUGH

In preparing bread dough, either a Readco (jacketed Sigma blade) mixer or two floor model Hobart mixers equipped with McDuffy bowls and mixers may be used. If a Readco is used, cold water should be circulated through the jacket while blending to retard bench action of leavening system. If Hobart floor model mixers are used, smaller batches on a semicontinuous basis are required.

1. Blend all dry ingredients thoroughly using slow speed on mixer. (Assure no lumps in either leavening) 5 to 10 minutes.

2. Blend in water gradually. Mix at medium speed until well blended. 1 minute.

3. Add the shortening to the mix and blend thoroughly at a medium speed for 7 minutes.

4. Dough may be transferred to filler by pump or by hand.

PACKAGING

1. The bread dough is filled in the foil pouches using a bottom fill technique at 71 grams, ± 2 grams.

2. Vacuum sealing is not required for this product, but residual air should be removed by a mechanical means prior to sealing. In lieu of such mechanical means, a very slight vacuum is acceptable.

3. The filled pouches are to be top sealed.

4. All packaging should be accomplished within two hours after blending.

THERMOPROCESSING

1. Thermoprocessing of bread should begin no later than three hours after batter is blended unless batter or packages are held at refrigerated conditions.

2. When approximately half the pouches from a batch have been filled, the pressure control can should be filled with product (71 grams) and the residual air evacuated through the pressure tap and shutoff valve. The differential pressure transmitter should be set at 2 psi allowing the internal package pressure to exceed the overriding (retort) air pressure throughout the process cycle.

3. With the filled pouches at room temperature, the processing water temperature at the beginning of a retort run should be at 80°F ± 5°F and the rate of temperature rise should be set at 8°F/minute consistent within ± 2°F throughout the retort.

4. The processing unit should be maintained at 250°F for 11 minutes and should be consistent to ± 2° throughout the retort.

5. The unit cool-down rate should be at 8°F/minute with temperatures throughout being consistent to ± 2°F. Products may be removed when water temperature falls below 100°F.

6. The above processing profile yielded F_o values of greater than 3 during product development.

Acceptance testing of final products.

Table B-VII represents mean acceptability scores for accepted bakery items thus far screened through Sensory Evaluation along with the individual panelists' ratings at all acceptance levels. All items were evaluated by a 10-member panel, except Chocolate Nut Cake which was judged by only eight panelists. The nine-point word hedonic scale was used, which represents a range of 1.00, or dislike extremely, to 9.00, or like extremely. A rating of 5 is neither like nor dislike.

TABLE B-VII SENSORY EVALUATION RATINGS SUMMARY
ACCEPTED PRODUCTS 13 - 17

Product No.	Item	Mean Acceptability	No. of Judges	Score
13	Fruit Cake	7.50	7	8
			2	7
			1	5
14	Orange Nut Cake	6.40	2	8
			4	7
			1	6
			2	5
			1	4
15	Pound Cake	7.20	4	8
			4	7
			2	6
16	Chocolate Nut Cake (Sample Log #9030)	6.50	1	8
			4	7
			2	6
			1	4
17	Bread	5.70	2	8
			2	7
			3	6
			2	4
			1	1

Task C Total Packaging and Processing System Specifications and Performance.

In order to establish effective communications with all contractors, it seemed imperative to establish a specification guideline for the materials and the inspection of these materials on the prototype equipment. Materials were procured against this guideline for testing different modules as they were being prepared. These guidelines will be further modified as technology is established in regard to equipment, products, and relationships between the products, materials, and equipment.

In order to establish guidelines and inspection stations, the prototype line was broken down into 14 modular inspection stations; these were numbered from 1 to 14 and are as found outlined later in this section (p. 75). Module 1 concerns itself with the web material which is fixed by contract to be a 50-gauge polyester x .00035-aluminum foil x .003-C-79 polyolefin. The product specification established for the pouch material is based on commercial standards and capabilities. The smaller quantities of material in Phase I were stock from a producing plant which were first validated against this specification. All pouch and roll stock that have been supplied to date have met these standards, as set down in the product specification, have provided seal strengths well within the target area, and have exceeded the specification minimums.

Module 2 is concerned with the pouch fabrication on the Bartelt machine. A deviation was requested from the initial 3/8" minimum bottom seal width requirements in order to increase the inside depth of the pouch and permit interface with the requirement of the Bartelt machine to have 5/16" unsealed area at the top of the pouch for the guide bar on the machine. Also at Module 2, the pouch description indicates a 3/4" maximum depth of the top seal; however, this leaves the top seal design and configuration open until experimental work is completed in the top seal design area.

Other module areas are additionally defined, pages 82 through 86. However, they cannot be more completely defined until complete definitions of processing equipment and material relationships are established. Additional inspection and testing in these different module areas will be more clearly defined as the program progresses.

It is recommended that the following specifications be used in the engineering and production phases of this contract.

In order to establish realistic specifications for certain systems, areas of active investigation were the evaluation of roll stock (3-layer laminate); the use of the laminate in pouch fabrication, handling through filling, final top sealing and processing; and inspection of the final pouch. These areas of investigation are discussed as follows:

Laminate Material Evaluation and Specifications.

The web material is fixed by contract to be 0.5-mil polyester/0.35 mil-aluminum foil/3-mil polyolefin. The raw materials used for manufacture of the laminate were validated against the raw materials specifications. Commercial roll stock laminate materials made from these raw materials were evaluated against the specifications (see Systems Specification Guidelines). The validated roll stock and pouches made from this stock material were supplied for tasks A, B, DD, and EE. Quality checks were conducted on roll stock and pouches were supplied for the various tasks, with results indicating compliance as shown in Table C-I. The air burst did not meet the 30-second come up and 30-second hold at 45 psi. This requirement is for "off the machine testing" and it should be noted that these pouches were aged and data to date indicate a 40-psi, 30-second hold level is more realistic for aged pouches. This aging factor is stabilized after two days from pouch manufacture. All pouches on a spot check passed the 30-second hold at 45 psi, as inspected from the pouch making machine.

Product Effect on Pouch Strength Integrity.

In order to establish the relationship of food products to pouch quality, 4 fatty sauces were selected, packed in pouches from lot 105-BF-6914, processed, and stored for evaluation. The four sauces selected were Sauce for Navy Beans, Barbeque Sauce, Gravy for Beef, and Chicken ala King Gravy. Since the sauce is intended to be less than 50% of the 5-oz. package fill, 3 oz. of sauce was used and finished pouches stored horizontally so sauce covered complete package surfaces. These sauces were packaged in 4-3/4" x 7-1/4" pouches sealed at 720 mm of vacuum on our laboratory Movac machine, processed at 250°F. for 30 minutes at 28 psig. total pressure. Bond strength between material lamina in the body and the seal areas, as well as side and bottom seal strengths, were tested before retorting, after retorting, and after storage for six weeks and three months at room conditions (75°F, 50% RH) and low humidity (100°F., 15% RH). Following the completion of the three months storage, the remaining pouches had the top seal removed, product removed by water wash, then the pouches were air tested for burst strength. The air test was performed by bringing pouches to 15 psi in 10 seconds, holding 10 seconds; then raising to 20 psi in 10 seconds, holding 10 seconds; then raising to 25 psi in 10 seconds; etc. until pouch ruptured.

The results of this testing are reported in Tables C-II through C-VI. These results generally show improved bond strengths between lamina material in the body area of the pouch after retorting. The slight drop (1180 to 1120) with Chicken ala King after retorting is attributed to uncontrolled variations among lots after it was noted that the 6 weeks and 3 months storage results followed the expected pattern. None of the fatty products tested caused seal strengths to fall below 12#/inch, thus staying well over contract specified level of 7#/inch minimum. The seal ply bonds were also maintained at over

TABLE C-I

QUALITY CHECKS

			LOT 1*	LOT 2**
(1)	Yield	STM-15	23.6 to 26.5 lb/M sq ft	23.2 to 26.7 lb/M sq ft
(2)	Odor	STM-1	9+ to 9+ Solvent 7.4 (7 to 9) Others	9+ to 9+ Solvent 7.6 (7 to 9) Others
(3)	Carbon Count	STM-185	.05 (0 to 0.2) p.p.m. as Toluol	.05 (0 to 0.2) p.p.m. as Toluol
(4)	Bond	STM-8	Polyester x foil 1000+ (800 to 1460) Foil x Polyolefin 1000+ (900 to 1280)	Polyester x foil 1000+ (900 to 1240) Foil x Polyolefin 1180 (1140 to 1240)
(5)	Seal Strength	STM-13	16.4 to 19.4 lbs./inch	16.1 to 17.6
(6)	Heat Resistance	STM-7	No delamination	No delamination
(7)	Air Burst	STM-147	45 psi. at 10 to 85 seconds All seals fused.	45 psi. at 10 to 85 seconds All seals fused.
(8)	Color	Visual	Olive Drab not used	Olive Drab not used
(9)	Appearance	Visual	Acceptable.	Acceptable.
(10)	Retortability		No delamination or deformation Flavor 7.4 (6 to 9) Retorted tap water.	No delamination or deformation Flavor 7.8 (6 to 10) Retorted tap water.

*	4800 pouches to Swift	1/16/70
*	2400 pouches to Pillsbury	1/16/70
*	2 rolls 2160 stock 18" O.D. 14-1/2" web to Bartelt	11/28/69
**	1 roll stock 18" O.D. 14-1/2" web to Bartelt	4/21/70

1,000 grams through this test. The pouch air burst test indicates that 30 psi at 10 seconds hold would be an acceptable level for this pouch with these products, which is well over the contract specified minimum of 15 psi for 10 seconds. Even though minor differences in bond and seal strengths occurred with the various products tested, these were considered insignificant as all were well above the specified minimum requirements.

Evaluation of Impulse Heat Sealing
Top (Closure) Seal

The sealing of the top of the pouches has been recognized as a major problem particularly with the possibility of contamination of the top closure area. Experience indicated that impulse type sealing would be highly desired for top sealing with contaminated seal areas. For this reason, impulse heat sealing of the top seal area was investigated in order to establish its suitability for the specified laminate material.

Tables C-VII through C-X show impulse seal data obtained using a laboratory Sentinel impulse sealer (Model No. 12 TPDW-110 Volt) using pressures of 25 and 50 psig with no contamination and with wet contamination. For the latter, the surface of the material was grossly contaminated with water prior to sealing. The seal curves were evaluated by using a Scott Model-J tensile tester operating at 12"/min pull rate on 1" wide specimens with 1" jaw separation.

TABLE C-II BOND STRENGTHS

BODY AREA
GRAMS/LINEAR INCH WIDTH

Product Packed		Initial Before Retorting	Initial After Retorting	After 6 Weeks Storage	After 3 Months Storage
STORAGE ROOM CONDITION (75°F., 50% RH)					
Sauce for Navy Beans	Average	1180*	1580	1253	1320
	Range	(1160-1200)	(1400-1800)	(1220-1300)	(1160-1420)
Barbeque Sauce	Average	1180	1400	1307	1500
	Range	(1160-1200)	(1360-1440)	(1260-1340)	(1480-1520)
Gravy for Beef	Average	1180	1750	1320	1445
	Range	(1160-1200)	(1600-2000)	(1200-1420)	(1400-1480)
Chicken ala King Gravy	Average	1180	1120	1247	1320
	Range	(1160-1200)	(1080-1160)	(1120-1400)	(1220-1400)
STORAGE CONDITION (100°F., 15% RH)					
Sauce for Navy Beans	Average	1180	1580	1210	1245
	Range	(1160-1200)	(1400-1800)	(1120-1300)	(1080-1320)
Barbeque Sauce	Average	1180	1400	1280	1307
	Range	(1160-1200)	(1360-1440)	(1220-1320)	(1280-1340)
Gravy for Beef	Average	1180	1750	1410	1315
	Range	(1160-1200)	(1600-2000)	(1400-1420)	(1260-1460)
Chicken ala King Gravy	Average	1180	1120	1270	1247
	Range	(1160-1200)	(1080-1160)	(1240-1300)	(1220-1300)

*800 grams/linear inch width is considered acceptable.

TABLE C-III BOND STRENGTHS

SEAL AREA
GRAMS/LINEAR INCH WIDTH

Product Packed		Initial Before Retorting	Initial After Retorting	After 6 Weeks Storage	After 3 Months Storage
STORAGE ROOM CONDITIONS (75°F., 50%RH)					
Sauce for Navy Beans	Average	2287*	2080	1727	2140
	Range	(2240-2340)	(1960-2180)	(1560-1900)	(2040-2260)
Barbeque Sauce	Average	2287	2186	1813	2030
	Range	(2240-2340)	(2040-2280)	(1620-1940)	(1880-2100)
Gravy for Beef	Average	2287	2105	2153	2150
	Range	(2240-2340)	(1900-2280)	(2080-2240)	(2040-2200)
Chicken ala King Gravy	Average	2287	2190	1933	2110
	Range	(2240-2340)	(2180-2200)	(1840-2000)	(1860-2200)
STORAGE CONDITIONS (100°F., 15% RH)					
Sauce for Navy Beans	Average	2287	2080	1640	1455
	Range	(2240-2340)	(1960-2180)	(1600-1680)	(1260-1800)
Barbeque Sauce	Average	2287	2186	2013	1927
	Range	(2240-2340)	(2040-2280)	(1900-2160)	(1900-1960)
Gravy for Beef	Average	2287	2105	2070	1895
	Range	(2240-2340)	(1900-2280)	(1980-2160)	(1720-2060)
Chicken ala King Gravy	Average	2287	2190	1920	1957
	Range	(2240-2340)	(2180-2200)	(1860-1980)	(1940-2020)

*800 grams/linear inch width is considered acceptable.

TABLE C-IV SEAL STRENGTHS

BOTTOM SEAL
POUNDS/LINEAR INCH WIDTH

Product Packed		Initial Before Retorting	Initial After Retorting	After 6 Weeks Storage	After 3 Months Storage
STORAGE CONDITION (100°F., 15% RH)					
Sauce for Navy Beans	Average	15.5*	15.6	14.1	15.5
	Range	(15.0-16.0)	(15.2-16.0)	(13.6-14.6)	(15.0-15.8)
Barbeque Sauce	Average	15.5	14.3	14.0	14.6
	Range	(15.0-16.0)	(13.2-15.4)	(13.6-14.4)	(13.6-15.4)
Gravy for Beef	Average	15.5	13.4	14.2	15.8
	Range	(15.0-16.0)	(12.2-14.8)	(13.0-15.4)	(15.4-16.2)
Chicken ala King Gravy	Average	15.5	12.8	14.2	14.8
	Range	(15.0-16.0)	(12.2-13.6)	(13.6-14.8)	(13.6-15.4)
STORAGE ROOM CONDITION (75°F., 50% RH)					
Sauce for Navy Beans	Average	15.5*	15.6	14.6	16.0
	Range	(15.0-16.0)	(15.2-16.0)	(14.4-15.0)	(15.4-16.4)
Barbeque Sauce	Average	15.5	14.3	13.7	15.5
	Range	(15.0-16.0)	(13.2-15.4)	(13.6-14.0)	(15.0-16.0)
Gravy for Beef	Average	15.5	13.4	14.7	15.8
	Range	(15.0-16.0)	(12.2-14.8)	(14.2-15.2)	(15.2-16.2)
Chicken ala King Gravy	Average	15.5	12.8	13.5	14.6
	Range	(15.0-16.0)	(12.2-13.6)	(12.4-14.2)	(12.4-15.8)

*12 pounds/linear inch in minimum acceptable.

TABLE C-V SEAL STRENGTHS

SIDE SEAL
POUNDS/LINEAR INCH WIDTH

STORAGE ROOM CONDITION (75°F., 50% RH)

Product Packed		Initial Before Retorting	Initial After Retorting	After 6 Weeks Storage	After 3 Months Storage
Sauce for Navy Beans	Average	16.2*	16.0	15.0	15.6
	Range	(15.8-16.4)	(15.6-16.6)	(14.8-15.4)	(15.2-16.0)
Barbeque Sauce	Average	16.2	16.3	14.9	15.9
	Range	(15.8-16.4)	(16.2-16.4)	(14.4-15.2)	(15.2-16.4)
Gravy for Beef	Average	16.2	16.9	15.5	15.7
	Range	(15.8-16.4)	(16.2-17.2)	(15.2-15.6)	(15.4-16.2)
Chicken ala King Gravy	Average	16.2	15.6	14.6	15.1
	Range	(15.8-16.4)	(14.8-16.4)	(14.4-14.8)	(14.4-15.8)

STORAGE CONDITION (100°F., 15% RH)

Product Packed		Initial Before Retorting	Initial After Retorting	After 6 Weeks Storage	After 3 Months Storage
Sauce for Navy Beans	Average	16.2*	16.0	13.9	14.7
	Range	(15.8-16.4)	(15.6-16.6)	(13.0-15.0)	(13.8-15.0)
Barbeque Sauce	Average	16.2	16.3	15.1	14.5
	Range	(15.8-16.4)	(16.2-16.4)	(14.6-15.4)	(13.6-15.4)
Gravy for Beef	Average	16.2	16.9	15.1	15.9
	Range	(15.8-16.4)	(16.2-17.2)	(14.4-15.6)	(15.4-16.0)
Chicken ala King Gravy	Average	16.2	15.6	14.2	14.9
	Range	(15.8-16.4)	(14.8-16.4)	(13.8-14.8)	(14.0-15.4)

*12 pounds linear inch is minimum acceptable.

TABLE C-VI
POUCH BURST STRENGTH (SIDE & BOTTOM SEALS)

POUCHES STORED 3 MONTHS

Product Packed	Psi Passed	Psi at Failure
	Storage Room Conditions (75°F., 50% RH)	
Sauce for Navy Beans	35*	36
Barbeque Sauce	35	36
Gravy for Beef	35	40
Chicken ala King Gravy	40	45
	Storage Conditions (100°F., 15% RH)	
Sauce for Navy Beans	30	33
Barbeque Sauce	35	40
Gravy for Beef	35	36
Chicken ala King Gravy	35	39

*Met holding requirement to 10 seconds.

TABLE C-VII

THERMAL IMPULSE SEAL CHARACTERISTICS (TOP SEAL)
50M-35F-300 C-79 Polyolefin
Stock 26-L-12-2158
(pounds/inch)

DRY (NO CONTAMINATION)

(Seconds of Impulse Cooling Dwell (25 psig)

Seconds of Heating Dwell	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
0.2	N/S	N/S	—	—	—	—	—	—	—	—	—
0.3	1.0	4.0	—	—	—	—	—	8.4	—	4.0	—
0.4	7.6	10.4	8.4	12.6	—	—	—	14.8	15.4	—	16.2
0.5	16.4	—	15.0	—	16.0	—	15.8	—	15.4	—	—
0.6	15.4	15.2	—	16.6	—	16.8	—	14.4	—	—	16.0
0.7	17.4*	16.4*	17.0*	16.6*	17.4*	16.4*	17.0*	17.0*	17.0*	16.4*	16.6*
0.8	17.0*	17.0*	16.4*	16.0*	17.2*	17.0*	16.0*	16.8*	17.2*	16.2*	16.4*
0.9	16.4*	16.6*	16.4	17.0*	17.2*	16.6*	17.4*	17.0*	17.6*	16.8*	17.6*
1.0	16.4*	16.4*	17.0*	16.8*	17.8*	17.0*	17.0*	17.0*	17.0*	18.0*	17.4*

*Fusion seal

TABLE C-VIII
THERMAL IMPULSE SEAL CHARACTERISTICS (TOP SEAL)
50M-35F-300 C-79 Polyolefin
Stock 26-L-12-2158
(pounds/inch)

WET (GROSS WATER CONTAMINATION)

(Seconds of Impulse Cooling Dwell (25 psig)

Seconds Of Heating Dwell	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
0.2	N/S	N/S	––	––	––	––	––	––	––	––	––
0.3	N/S	4.6	––	––	2.0	––	3.0	––	––	––	2.0
0.4	3.0	5.0	5.4	11.0	––	10.6	––	15.2	5.6	––	––
0.5	13.2	10.0	––	––	10.0	––	9.0	––	––	7.8	––
0.6	15.8	14.4	––	15.2	––	––	––	17.0*	––	––	––
0.7	16.2*	15.8*	11.4*	15.4*	17.4*	17.0*	16.4*	17.4*	17.0*	17.4*	16.4*
0.8	15.8*	15.0*	17.0*	16.0*	17.8*	16.0*	17.2*	17.0*	16.2*	17.0*	17.0*
0.9	16.0*	15.4*	16.8*	17.2*	16.0*	16.8*	17.8*	17.6*	17.2*	17.4*	17.6*
1.0	17.0*	16.4*	17.0*	17.4*	16.2*	16.6*	17.0*	17.0*	17.0*	17.6*	16.8*

*Fusion seal

TABLE C-IX
THERMAL IMPULSE SEAL CHARACTERISTICS (TOP SEAL)
50M-35F-300 C-79 Polyolefin
Stock 26-L-12-2158
(pounds/inch)

DRY (NO CONTAMINATION)

(Seconds of Impulse Cooling Dwell (50 psig)

Seconds Of Heating Dwell	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
0.2	N/S	N/S	N/S	——	——	——	——	——	——	——	——
0.3	8.6	——	N/S	N/S	N/S	N/S	——	——	N/S	——	——
0.4	15.8	14.6	——	——	15.8	——	13.0	——	16.0	——	——
0.5	16.0	——	——	——	16.6	——	——	——	——	16.4	——
0.6	16.4	——	16.4	——	——	16.8	——	16.4	——	——	——
0.7	16.6*	16.0*	——	17.0*	17.0 *	16.8 *	17.4*	16.8*	17.2*	17.0*	16.4*
0.8	17.0*	17.2*	17.0*	17.2*	17.0*	16.4*	16.0*	17.0*	17.0*	16.2*	17.0*
0.9	17.2*	17.2*	15.6*	17.8*	17.2*	17.0*	17.2*	16.4*	17.0*	17.0*	16.6*
1.0	17.4*	16.4*	17.4*	16.6*	16.4*	17.0*	17.0*	17.0*	17.0*	17.2*	17.4*

*Fusion Seal

TABLE C-X
THERMAL IMPULSE SEAL CHARACTERISTICS (TOP SEAL)
50-M-35F-300 C-79 Polyolefin
Stock 26-L-12-2158
(pounds/inch)

WET (GROSS WATER CONTAMINATION)

(Seconds of Impulse Cooling Dwell (50 psig)

Seconds Of Heating Dwell	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
0.2	N/S	N/S	—	—	—	—	—	—	—	—	—
0.3	N/S	N/S	—	N/S	—	6.0	—	—	—	—	—
0.4	3.0	5.0	—	—	6.4	—	—	5.0	—	—	8.0
0.5	5.8	5.4	11.8	14.8	6.0	—	—	11.2	10.0	12.4	12.0
0.6	10.0	13.4	—	16.0	—	15.0	15.8	—	—	—	—
0.7	14.0	14.6	15.4	16.0*	15.0*	17.2*	15.0*	16.0*	16.0*	16.2*	15.4*
0.8	16.0*	15.2	15.8*	16.0*	16.0*	16.0*	16.0*	16.0*	17.2*	16.0*	15.2*
0.9	16.0*	15.4*	16.4*	17.2*	16.2*	16.0*	16.0*	16.4*	17.6*	16.0*	16.0*
1.0	16.4*	15.4*	15.2*	17.0*	17.0*	16.2*	15.2*	15.4*	17.0*	16.2*	16.6*

*Fusion seal

The results at both pressure conditions show some slight necessity to increase impulse heat time in order to achieve fusion with the water contamination. These results show that effective strength and fused seals can be obtained quite easily with water contamination; however, the dwell time is higher than desired in order to fuse the seal. Laboratory tests with continuous cycling of the impulse sealer show that considerable design improvement would have to be made in the impulse sealer in order to prevent heat creep on extended running. This method of final top sealing was discontinued due to development of satisfactory results with thermal heat seal methods.

Evaluation of Thermal Heat Sealing
Side and Bottom Seals

In order to establish the sealing parameters for the side and bottom seal areas, thermal heat sealing of the laminate material was evaluated. Flat bars, consisting of a metal and rubber combination somewhat similar to the standard laboratory Sentinel sealers, were used in this study. This type of sealing is "prior art" for the production of retort pouches. Seal curves were run at 1/4-second and 1/2-second bar dwell times and at 25- and 40-psig pressure levels. These data are found in Table C-XI and show that there was no difficulty in achieving the 12# minimum individual seal strengths at either of the seal conditions studied. A fusion seal, which is the desired seal characteristic, was achieved in the 450° to 475°F. range with this material. Operating conditions slightly above this fusion point may be required to allow for machine drift. This information was supplied for the machinery design guidance.

Top (Closure) Seal
Thermal Heat Sealing Characteristics of Modified Bars With and Without Contamination – Laboratory Evaluation

Since the time requirements (both heat and cool) for impulse sealing were long, and since the U.S. Army Natick Laboratories had reported success in thermal heat sealing through contamination, it was decided that further investigations were warranted. Consequently, various bars designed for top and bottom jaws with different thickness and durometer rubbers were checked by running heat seal curves on our Sentinel laboratory sealer Model 12AS (see Figures C-1 and C-2). All seals were tested on a Scott Model-J tensile tester as previously described. Test data show that little difficulty is encountered in achieving a fused seal with most of these bar designs in the dry state; however, with water contamination considerable effect is noted. (See Tables XII thru XIV). Fat contamination also has an effect but in general not quite as great as water. Durometer values in the 65 to 70 range on the unheated jaw anvil proved to be the most desirable for overcoming contamination in the seal area. The BSK-5876 top seal bar (see Figure C-1,1), which is a rounded bar, produces a 12# minimum seal and approaches the target of 16 to 18#. Unfortunately it does not appear to give as good a reliability as desired and did not work as well in the experimental fixture; thus other bar designs were investigated. Model BSK-5882 top seal bar appears to give desired seal curves on 60- to 70-durometer rubber (BSK-5879 bottom seal bar) in the wet state approaching the

TABLE C-XI
LABORATORY SEAL EVALUATIONS
SEAL CHARACTERISTICS FOR BOTTOM AND SIDE SEALS
50M-35F-300 C-79 Polyolefin
Stock 26-L-12-2158
(Pounds/inch seal width)

Regular Sentinel Sealer Model 12AS

1 BAR HEATED METAL-RUBBER (56 DUROMETER)

Bar Temperature Fahrenheit		325°	350°	375°	400°	425°	450°	475°	500°	525°	550°	575°
1/4	(25 psig	N/S*	N/S	N/S	8.0	14.2	13.6	14.4**	14.1	15.0	15.0	15.6
Sec.	(				12.4	14.8	14.0	14.8**	14.6	15.2	15.6	16.2
Bar	(											
Dwell	(											
	(40 psig	N/S	N/S	N/S	11.8	14.0	14.0	14.2**	15.0	15.0	14.6	14.0
					14.0	15.4	14.2	14.4**	15.6	15.4	15.4	15.6
1/2	(25 psig	N/S	11.0	14.6	14.4	14.0	16.0**	15.8	16.2	14.2	15.8	13.0
Sec.	(		13.6	15.4	15.0	15.0	16.0**	16.4	16.6	15.6	16.0	15.0
Bar	(											
Dwell	(											
	(40 psig	N/S	13.2	14.0	14.4	15.4	15.4**	15.4	16.2	16.2	14.4	15.4
			14.2	14.6	15.2	15.8	15.8**	16.0	16.6	16.6	15.4	16.2

*No seal, i.e., less than 10 lbs./inch

**Fusion seal point

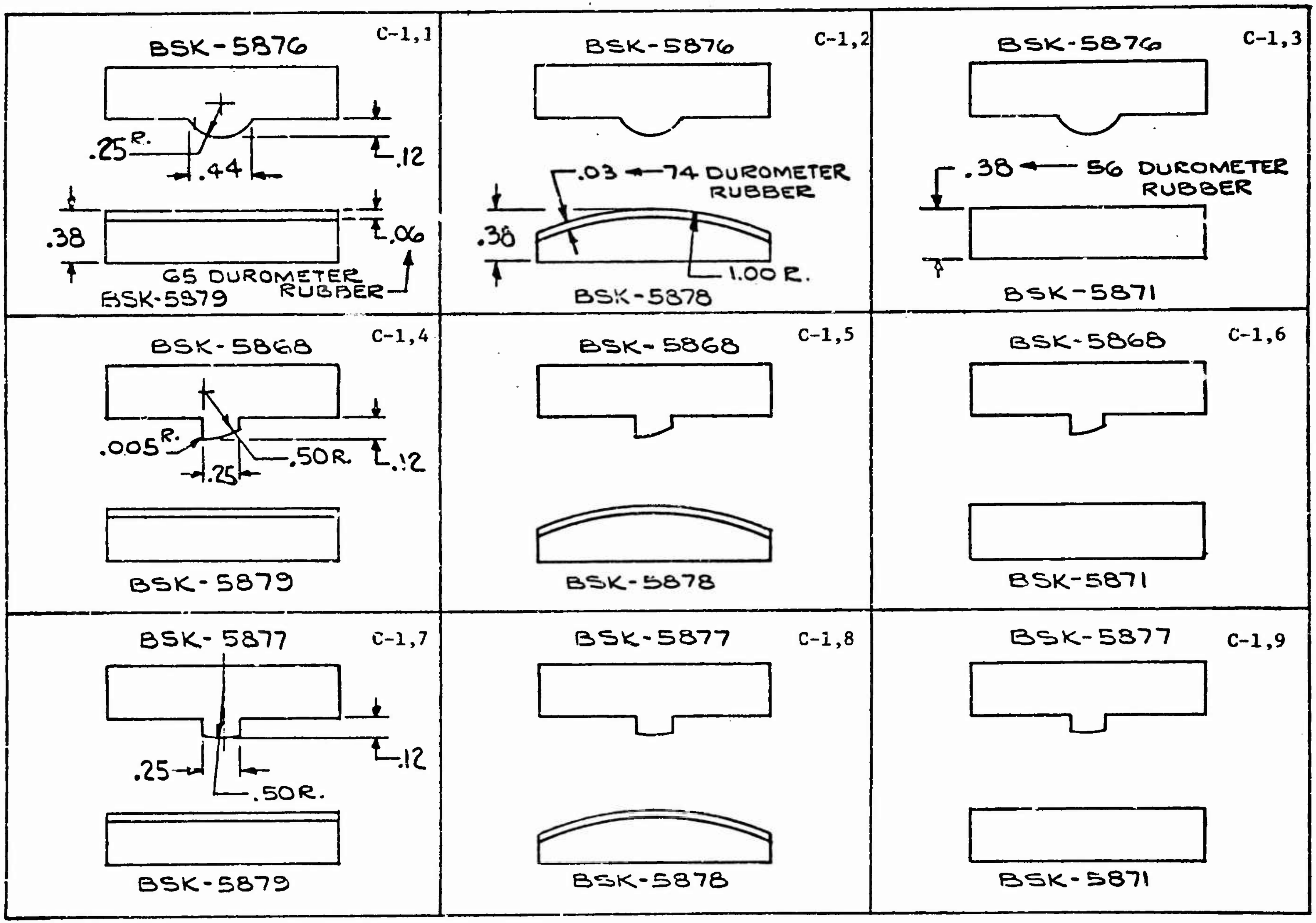
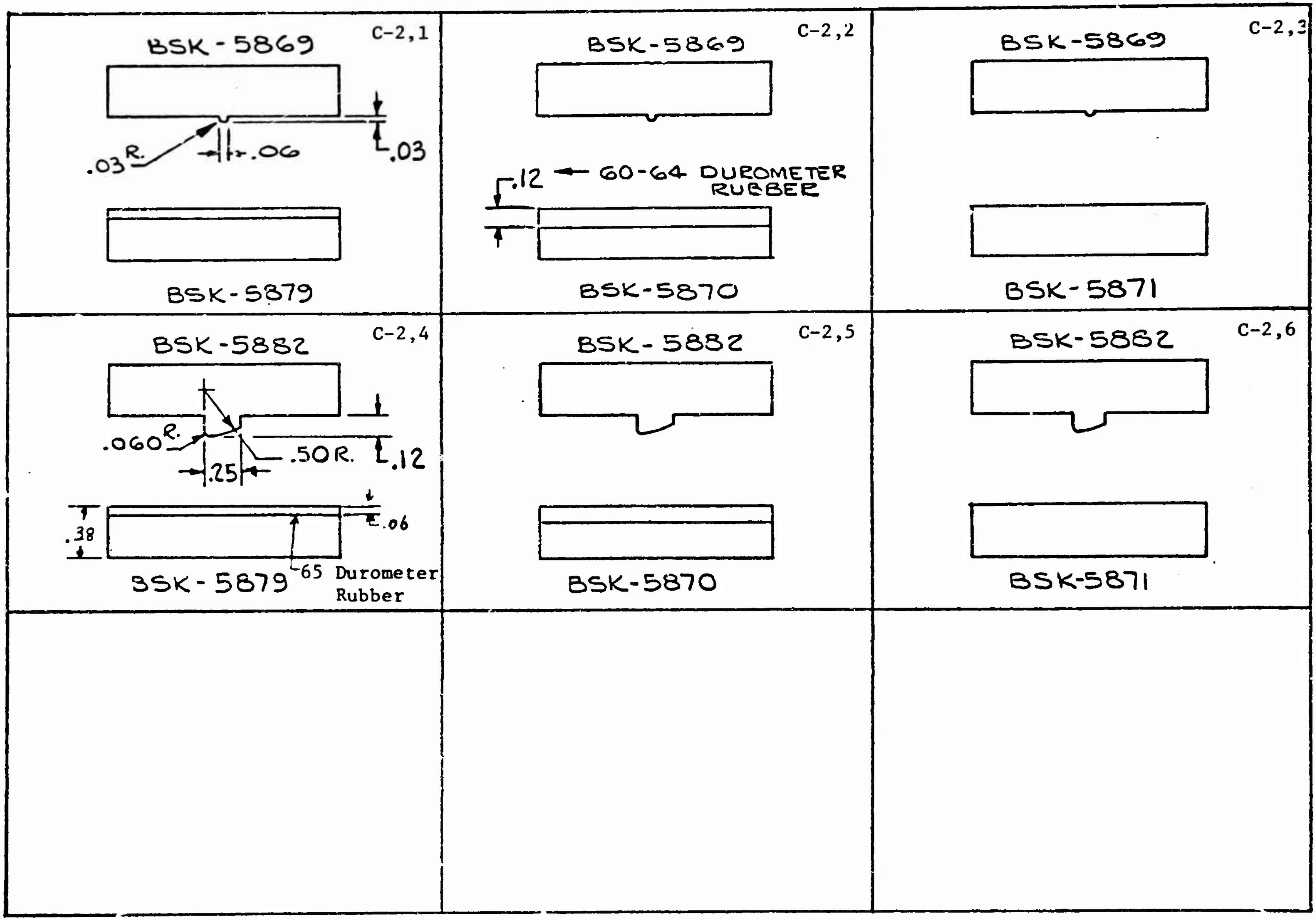


FIGURE C-1. Heat Sealing Bars and Anvils Used in Sentinel Heat Sealer Tests


C-2,1
BSK-5869
.03 R.
.06
.03
BSK-5879
C-2,2
BSK-5869
.12
60-64 DUROMETER RUBBER
BSK-5870
C-2,3
BSK-5869
BSK-5871
C-2,4
BSK-5882
.060 R.
.25
.50 R.
.12
.38
.06
BSK-5879
65 Durometer Rubber
C-2,5
BSK-5882
BSK-5870
C-2,6
BSK-5882
BSK-5871

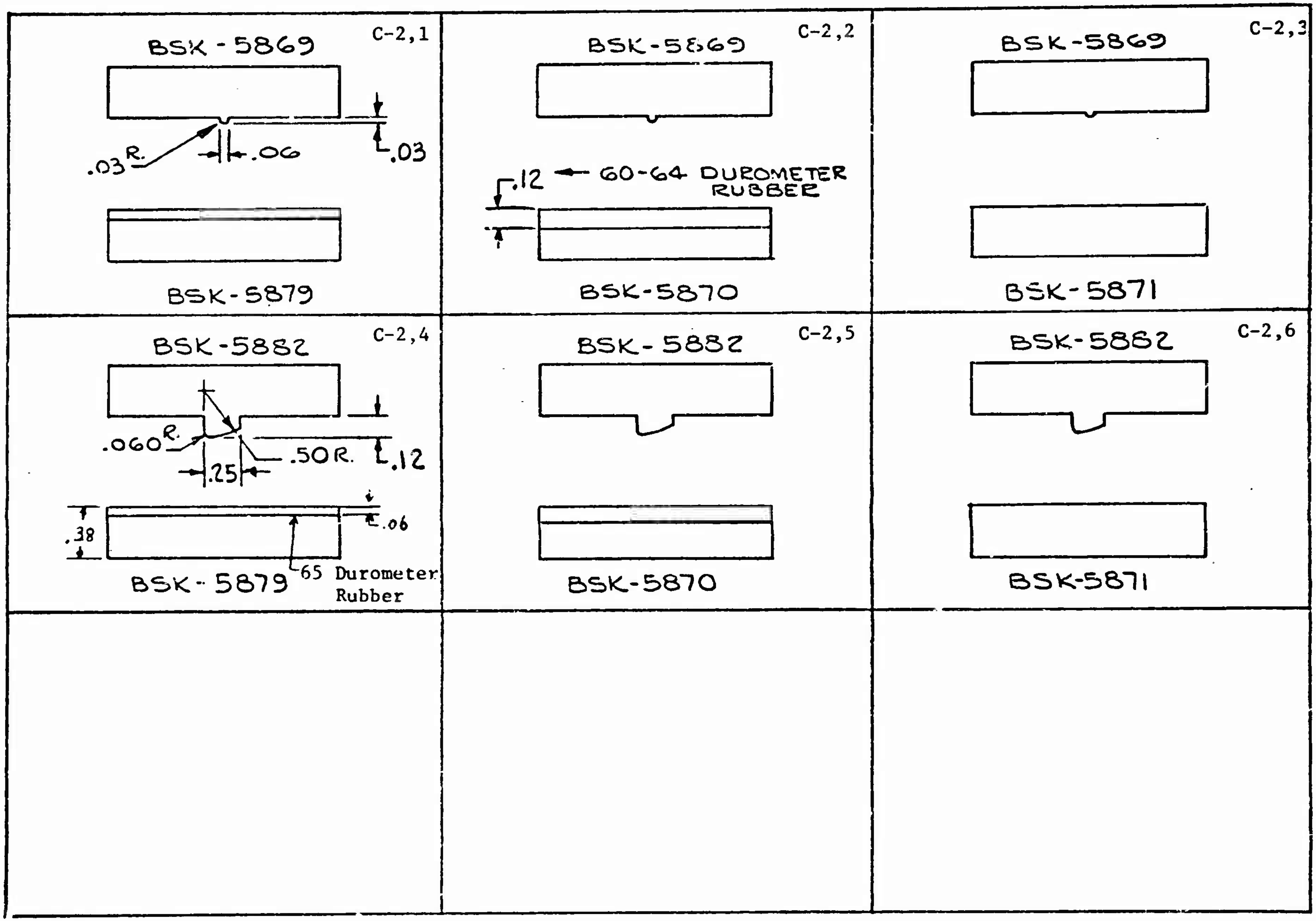


FIGURE C-2. Heat Sealing Bars and Anvils Used in Sentinel Heat Sealer Tests

TABLE C-XII
EVALUATION OF THERMAL HEAT SEALING
LABORATORY SEAL CHARACTERISTICS
50M-35F-300 C-79 Polyolefin
26-L-12-2158
(Pounds/inch seal width)

Top Bar No. SK-5882 – Bottom Bar No. SK-5879

Jaw Temperature Fahrenheit	375°	400°	425°	450°	475°	500°	525°	550°	575°
DRY (40 psig – 1/2 sec dwell)									
HI	N/S	12.1	16.8	17.6	18.2*	19.4	19.2	18.0	19.1
LO	N/S	7.2	14.8	17.0	17.8*	18.8	18.4	17.4	17.0
AV	N/S	8.9	15.8	17.2	18.0*	19.1	18.8	17.8	18.1
WET (40 psig – 1/2 sec dwell)									
HI	2.2	5.0	14.4	16.0	17.2*	18.0	15.6	12.4	11.2
LO	0.0	4.0	11.4	14.0	17.0*	16.0	12.4	10.4	9.0
AV	2.1	4.5	12.4	14.8	17.1*	17.0	13.4	11.0	10.1
FAT (40 psig – 1/2 sec dwell)									
HI	2.4	12.4	16.0	17.0	17.0	17.2*	12.4	17.2	17.2
LO	2.0	10.4	15.4	16.4	15.4	17.0*	10.0	14.0	12.6
AV	2.2	11.1	15.2	16.6	16.5	17.1*	11.2	15.3	14.8

*Fusion seal point

TABLE C-XIII
EVALUATION OF THERMAL HEAT SEALING
SEAL CHARACTERISTICS
50M-35F-300 C-79 Polyolefin
26-L-12-2158
(Pounds/inch seal width)

Top Bar No. SK-5882 – Bottom Bar No. SK 5879

Jaw Temperature Fahrenheit	375°	400°	425°	450°	475°	500°	525°	550°	575°
DRY (20 psig – 1/2 sec dwell)									
HI	7.0	15.0	10.2	17.0	17.6*	18.6	17.2	18.2	18.8
LO	5.0	13.2	8.0	13.4	17.2*	17.4	17.0	16.4	18.0
AV	6.3	14.0	8.8	15.7	17.4*	17.8	17.0	17.4	18.4
WET (20 psig – 1/2 sec dwell)									
HI	N/S	3.4	4.0	7.6	8.0	17.6*	16.6	15.8	17.0
LO	N/S	2.8	3.6	5.4	7.4	15.4*	15.4	14.0	15.6
AV	N/S	3.1	3.6	6.4	7.7	16.4*	16.0	14.7	16.5
FAT (20 psig – 1/2 sec dwell)									
HI	5.6	4.0	9.6	14.6	17.8*	17.4	16.6	15.0	17.8
LO	4.0	3.0	8.6	10.4	16.0*	16.4	14.0	13.0	15.4
AV	4.6	3.4	9.0	12.3	17.0*	16.8	15.5	14.1	16.6

*Fusion seal point

TABLE C-XIV
EVALUATION OF THERMAL HEAT SEALING
SEAL CHARACTERISTICS
50M-35F-300 C-79 Polyolefin
26-L-12-2158
(Pounds/inch lineal width)

Jaw Temperature Fahrenheit	375°	400°	425°	450°	475°	500°	525°	550°	575°
Top Bar No. SK-5882 – Bottom Bar No. SK-5871 WET (40 psig – 1/2 sec. dwell)									
HI	--	4.0	4.6	4.4	6.6	17.8*	16.4	14.8	15.4
LO	--	3.0	4.0	3.8	5.0	17.0*	14.0	11.4	14.6
AV	--	3.6	4.2	4.0	5.8	17.4*	15.4	13.0	14.8
Top Bar No. SK-5882 – Bottom Bar No. SK-5870 WET (40 psig – 1/2 sec dwell)									
HI	--	3.6	4.0	14.0	18.4*	17.4	15.4	17.0	17.4
LO	--	3.6	3.6	9.2	15.8*	17.0	13.0	14.6	13.4
AV	--	3.6	3.8	12.0	17.0*	17.1	14.1	16.0	15.9
Top Bar No. SK-5882 – Bottom Bar No. SK-5879 WET (40 psig – 1/2 sec dwell)									
HI	--	9.2	15.4	17.0*	18.0	18.0	--	--	--
LO	--	8.0	13.0	15.4*	17.0	17.0	--	--	--
AV	--	8.4	13.6	16.2*	17.6	17.5	--	--	--

*Fusion seal point

seal curve obtained with uncontaminated stock with the same configurations. The data indicate that with the harder rubber we are able to achieve these seal values without having to exceed seal temperature conditions in excess of 500°F. which are undesirable from material abuse standpoint. Thinner rubber may also achieve this purpose permitting perhaps even lower temperatures to be used. Results obtained on the Bartelt pouch forming module using 1/16-inch 50-durometer rubber have been satisfactory (see Task DD).

Thermal Heat Sealing Characteristics of Modified Bars With and Without Contamination – Bench Model Evaluation

Following the successful Laboratory Evaluations, tests were extended to a bench model system (Figures D-10 through D-16). The various top and bottom seal bar designs for pouch top closure as studied on the Sentinel 12AS laboratory sealer were evaluated on the bench model unit. This evaluation covered various top and bottom bar designs, seal pressures, closing speeds, and various contamination products and techniques. Peel seal strengths and air burst evaluations were used to judge seal characteristics.

Various studies conducted included seal bar design, seal bar temperatures, seal bar pressures, and levels of seal contamination using water and chicken ala king sauce as contaminate materials. Seal bar models BSK-5882 top seal bar and BSK-5879 bottom seal bar (see Figure C-2,4) were found to be most successful in overcoming seal area contamination. Data for this configuration are summarized in Table C-XV. This evaluation demonstrated that specification level peel seals can be obtained with and without product and/or water contamina . Air burst values to the desired 35-psi level could not be achieved with full heavy tamination which indicates an undesirable factor. The contract specification level of 15 psi for 10 seconds was readily exceeded. Pouches withstood 25 psi for more than 60 seconds with water and light product contamination. With heavy contamination the holding time was 45 seconds.

TABLE C-XV
BENCH MODEL EVALUATION OF THERMAL HEAT SEALING
WITH AND WITHOUT CONTAMINATION
SEAL CHARACTERISTICS

BSK-5882 TOP BAR HEATED 525°F – 40 PSI
BSK-5879 BOTTOM BAR HEATED 250°F – 40 PSI
SEALING RUBBER 5/16" MOLDED – TEMP 180°F
DWELL TIME – 0.4 SECONDS

Test Pressure Psi Air	Seal Contamination	Average Test Values: Burst Pressure Psig	Time to Fail (Sec.)
A. Air Burst			
35	Dry	35	60
"	Water	33	26
"	Ala King Sauce	32	23
25	Dry	25	60
"	Water	25	60
"	Ala King Sauce, Light	25	60
"	Ala King Sauce, Heavy	25	45
B. T-Peel (Lb/Linear Inch)		Overall Range	Average
	Dry	17.0 – 17.5	17.2
	Water	15.1 – 17.2	16.3
	Ala King Sauce	9.3 – 17.5	12.5

Thermoprocessing Heat Penetration

Heat penetration studies were conducted in order to establish the specifications for thermoprocessing. These studies included establishing loading and operation procedures for a horizontal retort using a typical product in carriers and racks. A water cook to the temperatures and pressures specified for the production guides (Task A and B) was evaluated.

The effect of the racks and carriers on heat distribution was studied in an experimental retort with bottom spreader feed. For this test, nine racks each with 12 carriers, with each carrier containing a 4-3/4" x 7-1/4" pouch vacuum-sealed with 5 oz. of chicken ala king sauce were used. The racks were placed 5 in the bottom layer and 4 in the top layer. Thermocouples were placed in the rack carriers as per Figure C-3. The tips of the thermocouples were attached to the pouch walls midpoint to the pouch heights. Thermocouples A, B, C, D, F and I were placed along the edge pouch seal. Thermocouples E, G and J were placed in the center of the pouch midpoint between the side seals. Thermocouples H and K were placed midpoint between the carriers in the water flow area. Thermocouple L was placed in the retort water out of the pack area just off the top of rack I.

Table C-XVI shows the thermocouple readings taken from a 12-point strip chart recorder which plots in sequence of 1-second intervals from A to L. Thermocouple H shorted out and was removed from plot.

The data shows very good agreement in temperature in come-up on thermocouples B and C which were in the bottom and top layers at each end of the pack. Also, good agreement was noted between E, G, and J which were in the center of the pouches at the lop layer in 3 different racks. The variations recorded are due more to error in reading the chart and thermocouple error, which all appears to be less than 2 degrees throughout the pack on come-up.

This data would indicate no major problems using this rack and carrier system for processing the meat, vegetable, and fruit items, but may be a problem with some of the bakery products. A full retort load study would be necessary to study the temperature distributions for the bakery products.

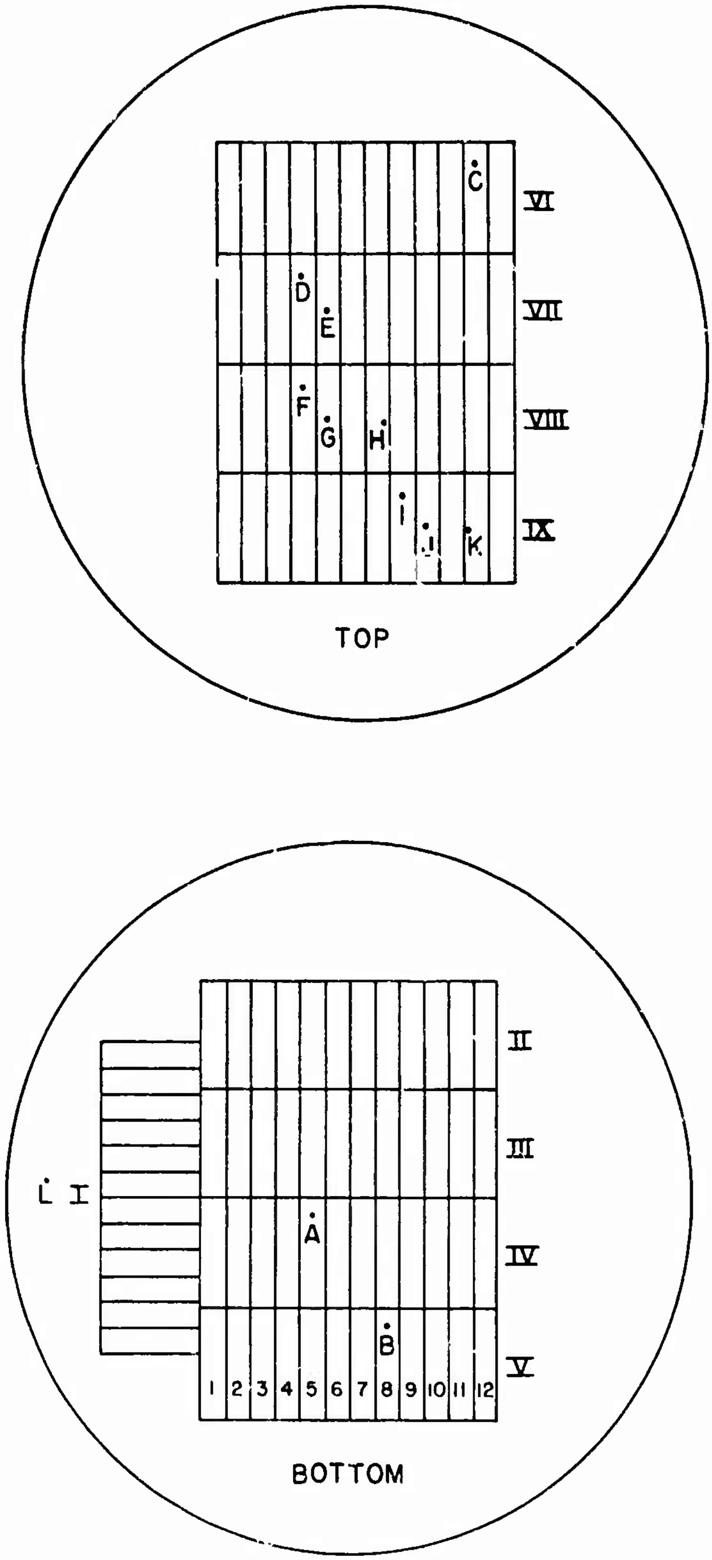


FIGURE C-3. Thermocouple Locations in Carrier Racks

TABLE C-XVI

HEAT PENETRATION – EXPERIMENTAL RACK & CARRIERS
THERMOCOUPLE READINGS – TEMPERATURE °F

Time in Minutes:Seconds	Bottom A	Layer B	C	Top D	Layer F	I	Pouch E	Center G	J	Between Carrier K	Retort Water L
	Pouch Seal Edge										
0:11-0:22	57	57	58	58	58	58	58	58	58	57	60
0:53-1:04	66	65	63	68	67	66	66	67	64	65	73
1:37-1:48	77	76	79	79	77	75	74	77	76	78	83
2:20-2:31	88	86	89	89	88	87	83	87	87	87	93
3:00-3:11	98	98	99	99	99	99	99	99	100	98	100
3:39-3:50	107	107	108	108	108	107	108	108	110	98	110
4:18-4:29	116	116	116	116	117	116	116	116	118	116	119
5:00-5:11	125	125	125	125	125	125	126	125	127	124	128
5:40-5:51	134	134	134	134	134	134	134	134	136	132	137
6:20-6:31	142	142	143	142	143	143	143	143	145	142	146
7:01-7:12	152	152	152	152	152	152	152	152	154	150	154
7:42-7:53	158	160	160	160	160	160	160	160	163	160	164
8:24-8:35	169	169	169	170	170	170	170	170	171	169	172
9:06-9:17	177	177	178	178	178	178	178	178	181	177	181
9:44-9:55	186	186	186	186	186	184	186	186	187	183	189
10:26-10:37	194	194	194	194	194	193	194	194	197	193	197
11:06-11:17	201	201	201	203	202	199	201	201	202	199	204
11:48-11:59	208	208	208	211	[illegible]	212	208	208	210	206	214
12:31-12:42	216	216	216	219	216	216	216	216	220	215	220
13:17-13:28	225	224	225	225	225	229	225	224	229	225	230
14:05-14:16	233	233	233	233	233	237	233	233	235	233	236
14:52-15:03	241	240	241	240	241	240	240	240	244	239	245
15:34-15:45	248	247	248	248	248	247	248	248	249	246	250
16:21-16:32	255	255	257	256	256	254	256	255	257	254	259
17:08-17:19	257	256	256	256	256	254	256	256	254	253	258
17:54-18:05	255	255	255	256	256	253	256	256	255	253	257

Figure C-4 shows, in flow chart form, the defined operations where performance specifications are felt essential and where inspections can be applied. These modules, as stated earlier establish a mechanism for delineating responsibilities and a means for effective communication. Following Figure C-4 are the tentative requirements for the individual modules.

MODULAR INSPECTION STATIONS

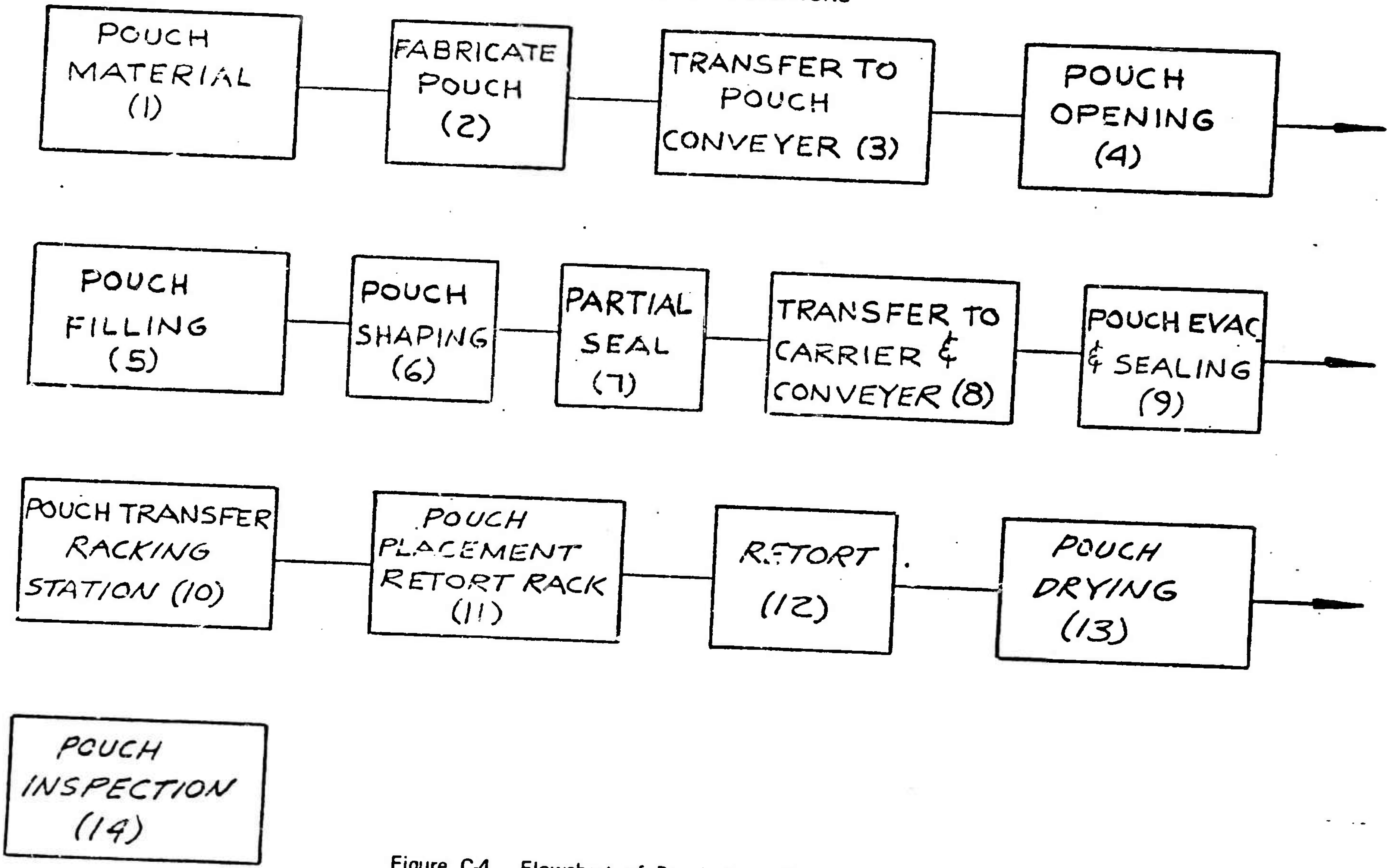


Figure C-4. Flowchart of Pouch from Forming Operation through Inspection.

POUCH MATERIAL – MODULE 1

Structure

1.	Polyester	50 Gauge
2.	Ink	Olive Drab*
3.	Adhesive	**
4.	Foil	.00035 Al.
5.	Adhesive	**
6.	Polyolefin	.003 C-79

* Color No. 34087 of Federal Standard 595
** Materials must meet FDA requirements

Product Specification

(1)	Yield	STM-15	22.5 to 27.3 lbs/M sq ft
(2)	Odor	STM-1	9 minimum Solvent 8 minimum Others
(3)	Carbon Count	STM-185	0.5 p.p.m. Max. (as Toluol)
(4)	Bond	STM-8	Polyester x foil: 800 gms/in. Minimum Foil x Polyolefin: 800 gms/in. Minimum
(5)	Seal Strength	STM-13 450°F., 40 psi 1/2 second Sentinel	12# Minimum, Individually Fused Seal 16#-18# Target
(6)	Heat Resistance	STM-7 450°F., 40 psi 1/2 second Sentinel	No delamination
(7)	Air Burst	STM-147	45 psi, for a 30-second hold period, Minimum When sealed – no seal yield or rupture. Sealed as under Item (5).

(8)	Color	Visual	Commercial Match to Standard.
(9)	Appearance	Visual	Material to be free of all recognized printing defects; hard wrinkles, starved or void adhesive areas, blisters or delaminated areas.
(10)	Retortability		Pouches filled with 5 oz. tap water to be retorted at 250°F. 30 minutes with no seal deformation, degradation, delamination or off-flavor of water. Flavor rating to be 7+.
(11)	Pouch Dimensional Tolerance	Scale Measure	Dimensional Size: As per Fig. C-5.
(12)	Roll Dimensional Tolerance	Scale Measure	*Web Width:* 14-1/2" ± 1/32" *Roll Diameter* 18" ± 1/2" *Core:* 6" I.D. unless otherwise specified. Must not be recessed at either edge of roll, but may extend up 1/8" beyond either edge of roll.

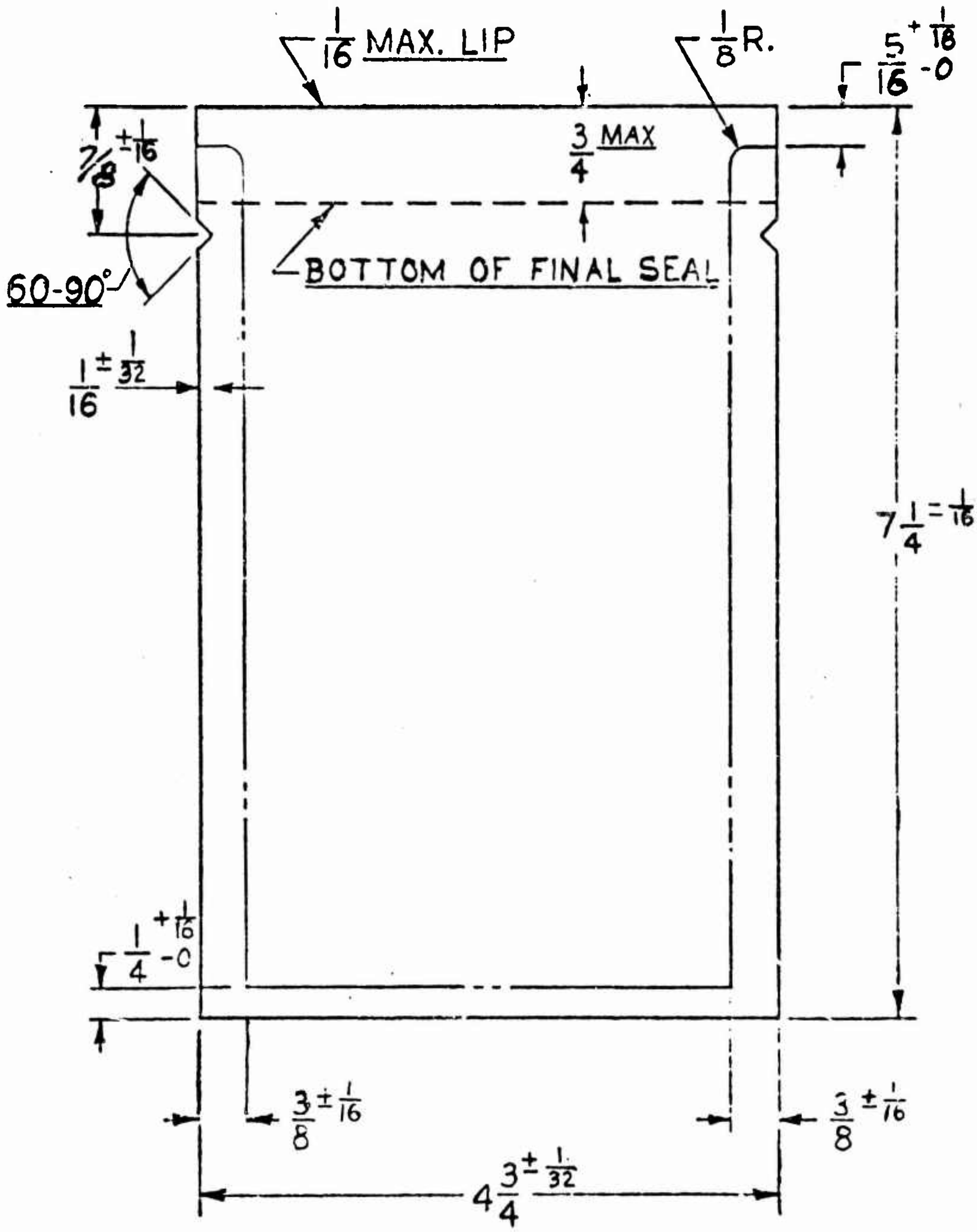


FIGURE C-5. Flexible Pouch Dimensions

POUCH FABRICATION MODULE 2

Roll Stock Specification:

Web Width:	14-1/2" ± 1/32"
Roll Diameter:	18" Max ± 1/2"
Core:	6" I.D., Flush Must not be recessed at either end, but may extend up to 1/8" beyond either edge of roll.
Roll Formation:	Uniform, no soft edges, no wrinkles. Stock tape attached to core. Heat seal side wound in.
Roll Wrap:	Protective wrap to avoid contamination & damage (1) polyethylene wrap/metal end plugs. (2) Outer surface to be wrapped with corrugated puncture proof sleeve. In fiber drums (2/drum) with corrugated spacers.
Identification:	Order #, Master Roll #, Cut #, Lineal Footage per Roll Web Width.
Storage:	Maintain a relative humidity range of 35 to 60% and temperature within 60° to 80°F. Avoid exposure to odoriferous environments (e.g., organic solvents and vapors). NOTE: Stock should be at packing room temperatures for 24 hours prior to use on packaging machine.
Flat Pouch Dimensional Tolerances:	**Module 2**
Length O.D.	As per drawing 7-1/4" ± 1/16"
I.D.	7 ± 1/16"
Width O.D.	4-3/4" ± 1/16"
I.D.	4" ± 1/16"

Lip	0 to + 1/16"
Side Seals	3/8" ± 1/16"
Bottom Seal	1/4" Minimum + 1/16 or – 0*
Tear Nicks	Side to side V-notch 60° to 90° angle.
	1/16" deep ± 1/32"
	located 7/8" from top edge of pouch ± 1/16"
Wrinkles	None permitted
	Pouch walls shall be flat showing no deformation or strain which results in final seal wrinkles.

* Inner edge of bottom seal to be completely linear with no lap or weak spots. Pouch seals and cut edges should be at 90° ± 1° angle.

Sealing Mechanism Specifications: **Module 2**

Seal Bars: Side* & Bottom

Seal Chill Bars	Provided for on Side & Bottom Seal
Seal Bar Edge Radius:	To assure no sharp edge (.0005" to .0010")
Teflon-Fiberglass Cloth Cover Equipped Metal Bars	
Side & Bottom Seal Jaws:	1 Side Silicone Rubber (1/16" 50-Durometer Grade FR 132) Coating
	1 Side Metal
Seal Bar Alignment:	As required to avoid heat creep (45# Air Burst)
Jaw Pressure:	40 psi ± 5 lbs.
	1/8" Radius at inside top of pouch

*NOTE: Side Seal Bar

Temperature Range:	250° to 600°F (pending refinement on Bartelt's experience)
Temperature Uniformity: Seal Bar Surface	± 10°F. throughout range.
Tear Notch:	Clean cut with no jagged edges and this operation shall result in no deformation of pouch material.
Web Feed Rolls:	To pull web uniformly and in no way damage or deform pouch material.
Cut-off Station:	Clean cut to provide smooth edges (no jagged edges) and in no way damage or deform pouch or affect transfer to next station.

Chart Recorder & controller for seal bar temperature control – with high-low limit warning lights.

Flat Pouch Inspection at Cut-off Station:	Module 2
Air Burst:	STM-147 – 45 psi. min. 1/16" yield permitted
Seal Strength:	STM-13 – 12#/min. Ind. 16-18#/inch Target
Heat Creep:	Visual Examination
Pouch Dimensions:	See Fig. C-5
Pouch Deformation and/or Damage	Visual Pinhole per STM-147

NOTE: Inspection to be done on pouches produced at 30 to 60 pouches per minute on continuous operating basis. Details of testing to be added. Acceptance testing of pouch forming sealing modules to be performed at cut-off station.

Transfer to Pouch Conveyor Module 3

Double gripper system

Must grip seal area only

Properly positioned for opening and filling

Visual inspection.

Pouch Opening Module 4

Cannot distort or damage pouch, pouch seals or mis-position pouch.

Acceptance Testing:

Air Burst – 45 psi.

Visual inspection

Pouch Filling Module 5

(1) 30 to 60/min filling rate

(2) There shall be no seal area contamination by the filling operation.

(3) Fill weight and volume to be as specified for each product.

(4) Entrained air – all filling and delivery equipment to minimize air in product and pouch.

(5) There shall be no damage to pouch side seals or pouch walls by filling mechanism.

(6) Product position in pouch – all of product to be 1-1/2" below the top edge of pouch.

(7) All filling equipment to be smooth and free of sharp edges, burrs, etc.. which may damage pouch walls.

Inspection

Visual and air burst

weighing
timing of rate

Pouch Shaping **Module 6**

Filled pouch to be shaped to fit carrier and distribute product but not force product to pouch top area to cause seal area contamination. Shaping must not distort or damage pouch walls or seals.

Partial Seal **Module 7 (Postponed, may be required in Phase II)**

No contamination of top seal area partial seal.

If used must be located with bottom edge a minimum of 1/8" above bottom edge of final closure seal.

Must not deform seal area in any manner that interferes with final seal flatness or integrity.

Partial seal must not interfere with headspace gas removal in vacuumizing operation or permit product seal contamination.

Transfer to Carrier and Conveyor **Module 8**

(1) No seal area contamination by transfer operation.

(2) Smooth motion.

(3) Smooth motion to avoid seal contamination from product movement.

(4) Transfer mechanism, carrier, and conveyors to be inspected for smoothness, no sharp edges, corners, which can damage or score pouch walls.

(5) Must permit proper positioning of pouch ± 1/8" maximum variation of top edge of carrier.

(6) Pouch seals should be kept in natural flat state not folded up or over.

Visual check of top seals for contamination. Visual check of equipment and pouch position in carrier.

Pouch Evacuation & Sealing   Module 9

(1) No seal contamination or wrinkles in seal area.

(2) Vacuum chamber will be pulled to 26' of vacuum. Residence time before sealing shall be no less than 4 seconds.

(3) Final seal dimension to be 1/8" minimum and to be no more than 3/4" from top edge of pouch and must be below radiused areas on side seal.

(4) There shall be no wrinkles or deformation of the pouch due to top seal operation.

(5) Final seal strength shall be 12#/inch min. – 16 to 18#/ inch target.

(6) The residual gas in the pouch at time of final seal shall be no more than 10 cc.

(7) Inspection to be accomplished on pouches produced at 60 per min.

(8) Pouch must withstand 35 psi 30-second hold period minimum on top seal area with a target of 45 psi. as per STM-147
(Detail to be added following initial production line trials.)

Inspection Testing

(1) Air test top seal

(2) Residual gas headspace

(3) Visual

(a) Wrinkles pouch damage
(b) Positioning in carrier
(c) Dimensions

Pouch Transfer Racking Station   Module 10

Collection to be such to not abuse pouch and keep carrier in upright position.

Pouch Carrier Placement in Retort Rack   Module 11

(1) Transfer operator must not handle pouches manually.

(2) Pouch in carrier must be oriented vertically in the retort.

(3) Rack assembly must not fold or distort pouch.

(4) Rack must confine pouch but not impose pressure or prevent free expansion of pouch to carrier thickness but not permit thickness of pouch to exceed carrier internal thickness.

(5) Rack system to be inspected for lack of burrs and other sharp areas that can cause cuts or abuse to pouch walls or seal areas.

(6) Rack and carriers should not be over 20 lb.

Retort Module 12

(1) Process must be an underwater process with superimposed air pressure and is not to be a steam-air mixture or steam process.

(2) Air pressure to provide at least 35 psi. in retort.

(3) Air to be mixed with steam prior to entering retort to aid in temperature distribution and to be distributed through steam header. Also provide for air entrance above operating water level.

(4) Retort to be horizontal style with doors on each end.

(5) Retorting capacity to be such to accomodate 6,336 pouches; tentatively 60" diameter, two units 12' long each.

(6) Retort to be designed to provide optimum flow of water, steam, and air to provide uniform heat distribution throughout retort and optimum come up time and cooling time to reach process and cooling temperature.

(7) Air supply and control must be sufficient to provide for less than 1 psi. fluctuation during complete process and cooling cycle.

(8) Provision must be made to feed cooling water in from bottom and provide uniform cooling.

(9) Retort process temperature control must maintain temperature throughout retort within ± 1°F.

(10) Provide ready access into retort for 12 minimum thermocouple leads to make heat penetration measurements.

(11) 15 minutes come-up time (steam on).

(12) Recorders, automatic control systems. Differential pressure control device.

(13) ASME rating of 50 psi. min. required.

(14) Process at 195°, 240°, and 250°F.

(15) Water level sight glass.

Pouch Drying Module 13

Drying tunnel approximately 20 ft. long, 2 ft. wide, 5 ft. high. Heated air at approximately 120°F will be blown on the pouches to remove the moisture. Capacity – 30 to 60 pouches per minute. Unit will be similar in design to unit now in production at Cranberry Products, Eagle River, Wisconsin.

Pouch Inspection Module 14

Statistical samples for:

(1) End item requirements

(2) Pouch burst strength test

(3) Residual gas measurement

All pouches subject to 100% inspection for workmanship and defects.

Task D Technical Feasibility of the Packaging System

This task concerns the establishment of the technical feasibility of the packaging system. Technical feasibility can be established by precedent, by extrapolation from precedent through theoretical analysis, by bench models developed to prove new techniques, or by combinations of the above where necessary.

The packaging system intended to be built in Phase II consists of the following items:

1. A Bartelt form/fill/seal machine which will form the specified laminate, seal the two sides and the bottom in the vertical position, separate the web into discrete pouches by a vertical separating shear, fill the formed pouches through the top with product by means of various filling devices, and transfer the filled pouches to an intermediate device for assembling the pouch into the carriers (see Tasks DD and E).

2. A transfer mechanism for assembling the carriers with the pouches and depositing the filled carriers onto a conveyor.

3. A conveyor for transferring the pouches to the infeed section of the vacuumizing and closing machine.

4. A modified Continental Can 216 vacuumizing and closing machine for evacuating and top sealing the filled pouches.

5. A discharge conveyor from the 216 vacuumizing and closing machine for conveying the carriers to an accumulation table.

6. A loading area where the carriers will be manually inserted into retort racks.

7. A loading area for loading the retort racks into cars.

8. A retort for thermoprocessing the package (see Task EE).

9. An unloading area, where the individual pouches will be put through a drying tunnel and the carriers and racks will be recycled to the transfer and carrier assembly machine (Item 2 above).

10. An area for visual inspection of pouches.

11. An area for manually gluing the assembled pouches into a manually formed overwrap, with provision for code marking the packages.

12. An area for labeling and manually loading the packages into fiberboard containers for shipping.

Many of the above functions are prior art and have been in commercial use for years; others are unique to this process and thus require demonstration of feasibility. Modules of the packaging system requiring feasibility determination under this task included the transfer of the pouch, vacuumizing and heat sealing, and heat seal parameters.

The method of transferring the pouch from the form and fill module is similar in principle to the transfer mechanism of the Bartelt continuous motion form, fill, and seal machine. The concept of applying this principle to the intermittent motion form and fill module is shown on Figure D-1. This layout shows the transfer unit and its drive from the intermittent motion form and fill module.

The pouch will be transferred from the horizontal indexing feed chain of the form and fill module to a vertical indexing chain that is part of the transfer module. The vertical chain moves the pouch to the assembly station where the carrier is elevated to encompass the pouch. The vertical chain then releases the pouch to the carrier and a horizontal lug chain moves the carrier containing the filled pouch to the infeed conveyor of the vacuum sealing module.

We have demonstrated the feasibility of the transfer of the pouch from the pouch carrier chain of the form/fill module to the chain of the transfer module by construction of the mechanism. The design of a feed mechanism for assembling the pouches and carriers in the transfer module has been made. See Figure D-1. We feel this is a straightforward mechanical design and feasibility need not be demonstrated. The same is true of the transfer of the carrier to the infeed of the vacuumizing and heat sealing module. Staged vacuum and thermal sealing has been demonstrated on the actual equipment to be used (Figure D-2). We recommend these designs be used for the production system.

Transfer of Pouch

The nonrigid nature of the filled container posed unusual problems in gaining and retaining control of the pouch through all facets of the process. After leaving the form/fill module where conventional methods are used for controlling the pouch, it was found necessary to assemble the pouch into a pouch carrier (see Task E) which is, in effect, an open-topped rectangular container, used to transport the assembled pouch by techniques used in handling metal cans. The transfer method is such that presealing is not considered necessary. The pouch carrier will be die cast of aluminum, and will provide a suitable structure for controlling the package from the instant it leaves the form/fill module until it is withdrawn from the carrier for drying. The carriers will be recirculated to the transfer machine after the pouches are withdrawn. Approximately 6,000 pouch carriers will be necessary for operating the line proposed in the production phase, the exact figure depending upon retort capacity.

For further details see Task E.

TASK D

Technical Feasibility of the Packaging System

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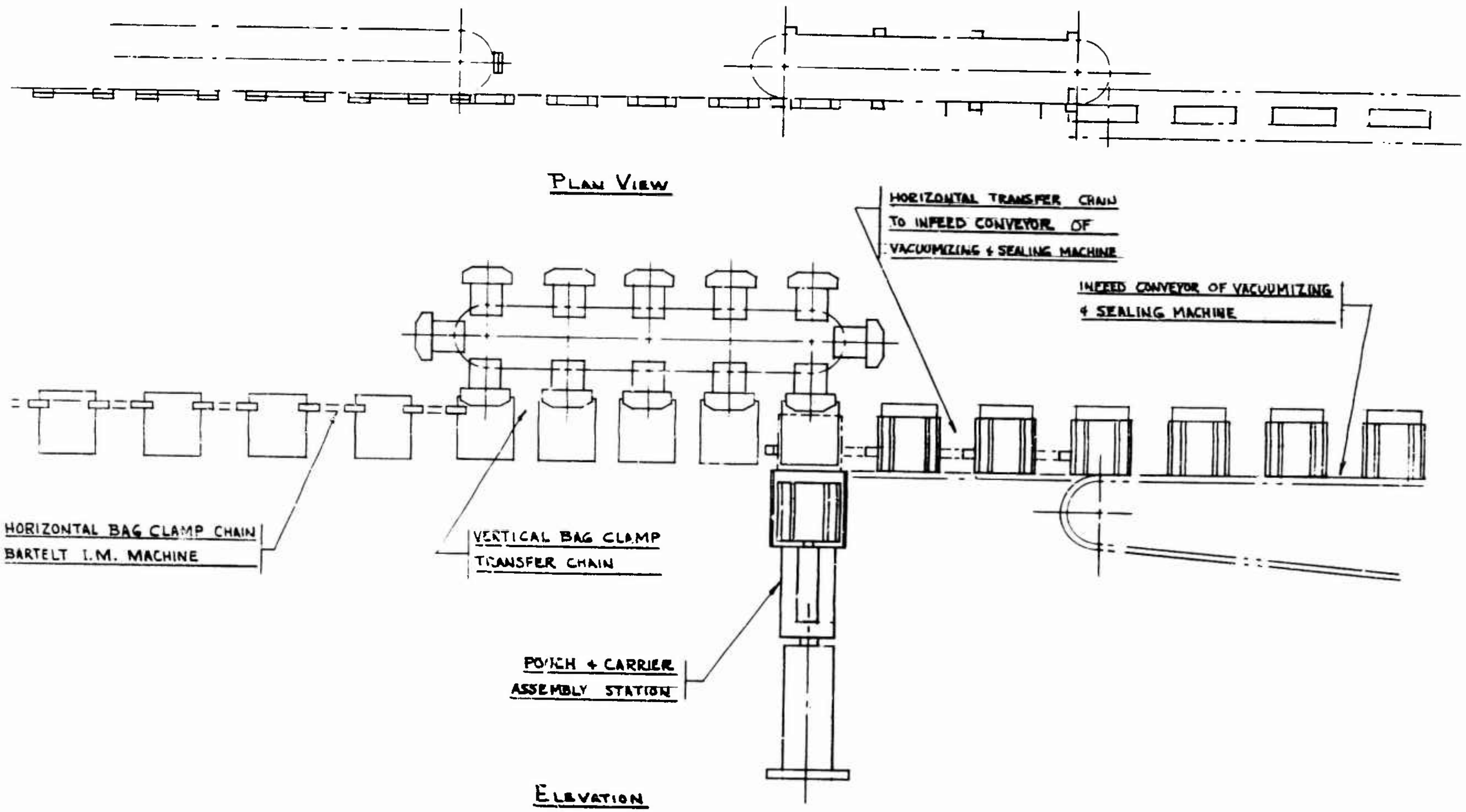

Figure D-1 Pouch to Carrier Transfer Procedure

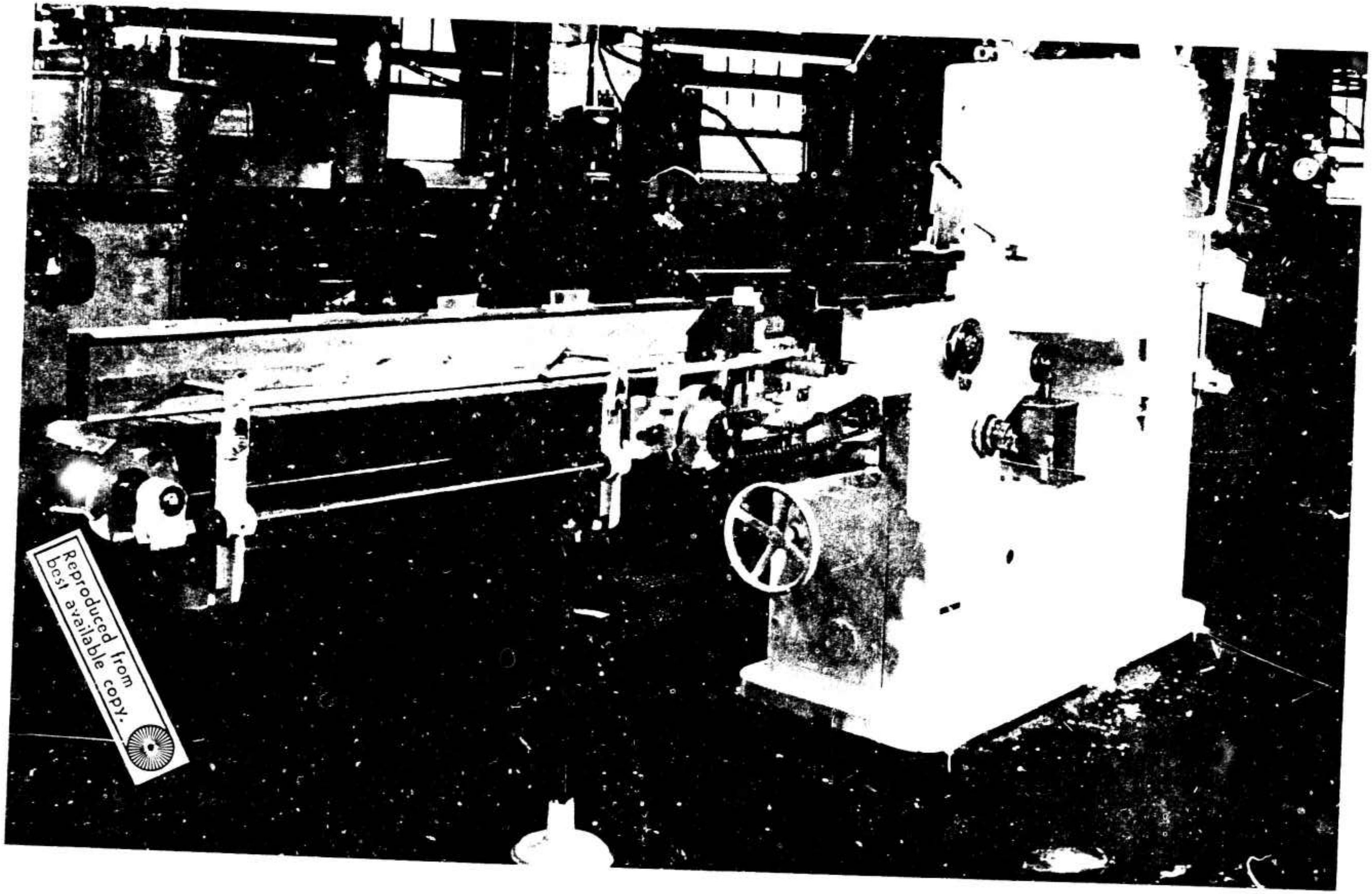

Figure D-2 Vacuum Closing Machine Showing Carrier Feed

Vacuumizing and Heat Sealing

It is necessary to reduce the residual gas levels in the sealed pouch to less than 10 cc's by use of vacuum prior to sealing.

Because of the pouch carrier concept, it was found possible to modify a can vacuumizing and closing machine for vacuumizing and heat sealing flexible pouches. The Continental Can 216-VOC machine, normally used for irregularly shaped cans, was modified to accept the pouch carrier in its handling system, and to include thermal heat sealer bars instead of the conventional can seaming mechanism. This machine has an intermittent rotary motion, and the parameters for heat sealing are such that 60 pouches per minute can be sealed if the seal areas are not contaminated (see Task DD).

Figures D-3 through D-8 of the Vacuum and Sealing module show the assembled carrier and pouch in various positions in the machine.

Figure D-3	Top View of Infeed of Pouch Carriers to 216 VOC Machine.
Figure D-4	View of Pouch in Carrier in 216 VOC Heat Sealing Station.
Figure D-5	Side View of Heat Sealing Station, Heat Seal Bars Removed.
Figure D-6	Carrier Elevated to Sealing Position.
Figure D-7	Side View of Sealing Head in 216 VOC Machine.
Figure D-8	View of Discharge of 216 VOC Machine.

The vacuumizing and heat sealing module will be equipped with the following features (Figure D-9):

1. Automatic Feed
2. Staged vacuum — three stages before the final vacuum chamber.
3. Approximately four seconds from atmosphere to 27" Hg. vacuum.
4. One heat sealing station arranged for thermal hot bar sealing.
5. Automatic discharge.
6. This machine will be capable of mechanical operation at 30 to 60 pouches per minute.

Tests have been run with filled pouches which demonstrate that a desired vacuum (approximately 27" Hg) applied on the 216 machine at a cycle speed of 30 per minute will not cause product to be lifted to a point where it will contaminate the seal area as entrained air is withdrawn. This had been demonstrated with selected products chosen to represent properties of the 12 non-bakery food items. The optimum vacuum staging and exact cycle speed for each product will have to be determined on the production line with machine filling.

The sealing mechanism in the 216 machine has been demonstrated with a knurled Teflon coated hot bar. The backup bar has a 1/16" layer of silicone rubber. The temperature of the hot bar is nominally 500°F, ranging from 500° to 475° during the cycle. The backup bar is heated to a nominal 250°F, which provides a greater latitude in the sealing process. These are shown in Figures D-10 and D-11.

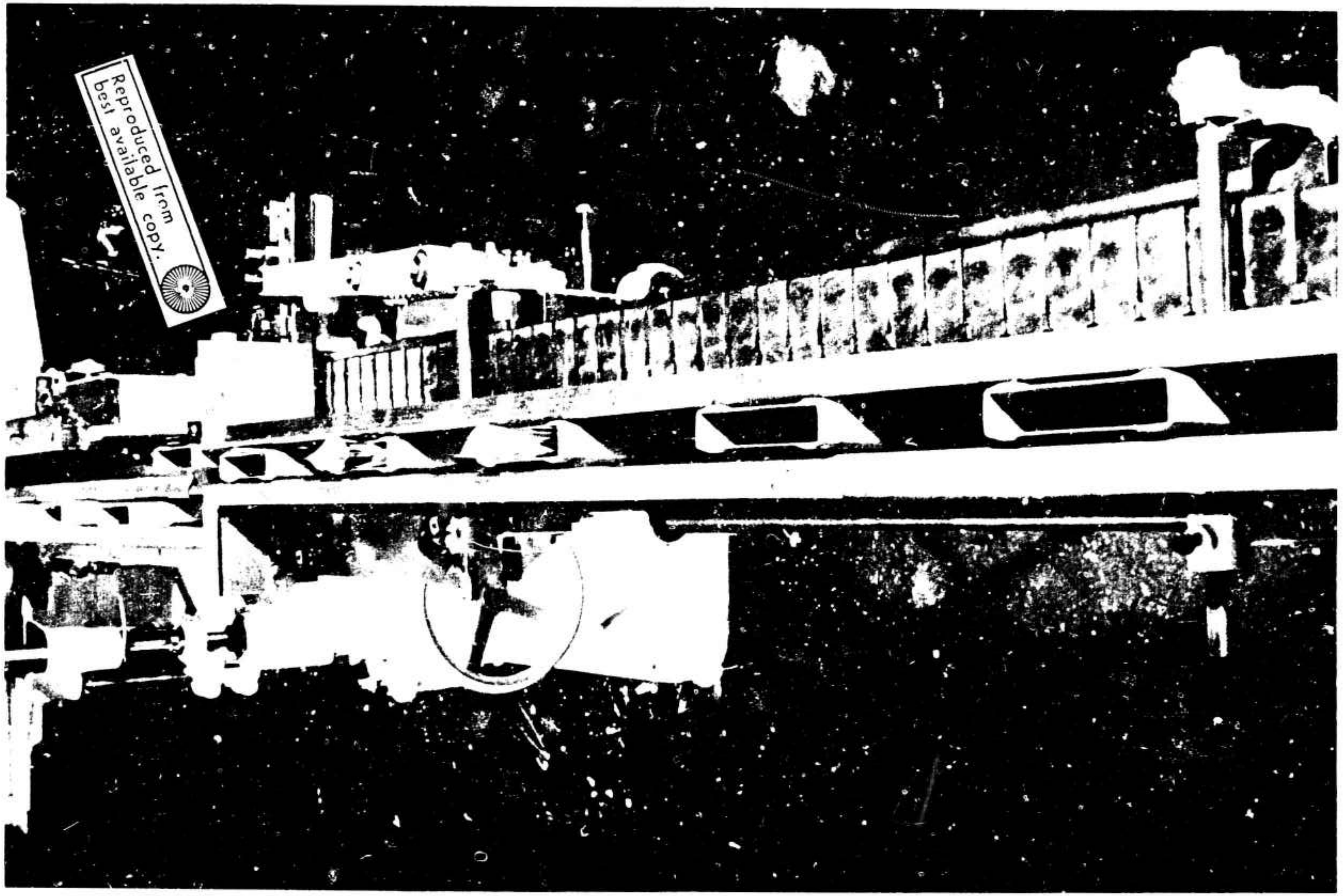

Figure D-3 Top of Infeed of Pouch Carriers to 216 VOC Machine

Figure D-4 View of Pouch in Carrier in 216 VOC Heat Sealing Station

Figure D-5 Side View of Heat Sealing Station, Heat Seal Bars Removed

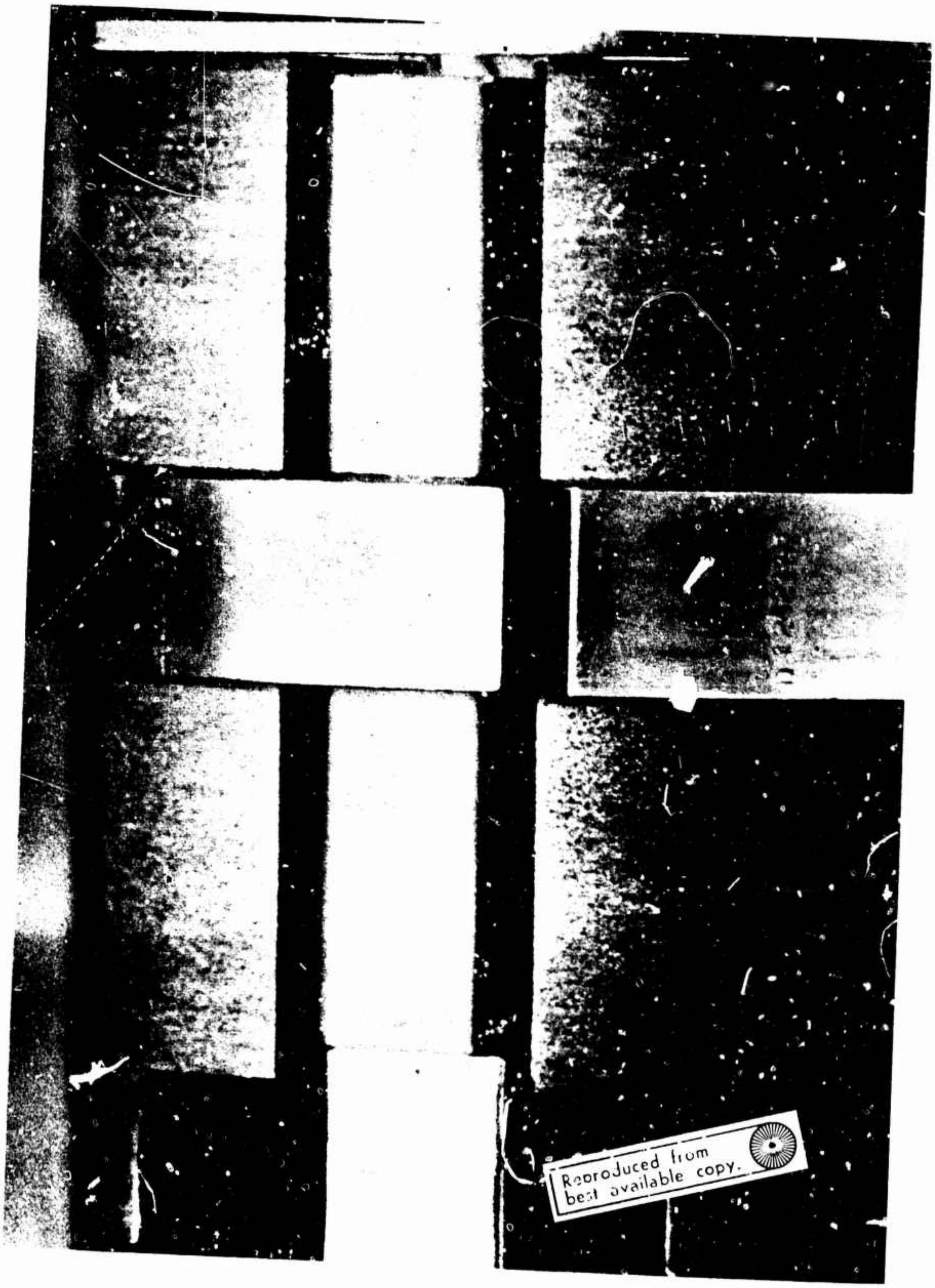

Figure D-6 Carrier Elevated to Sealing Position

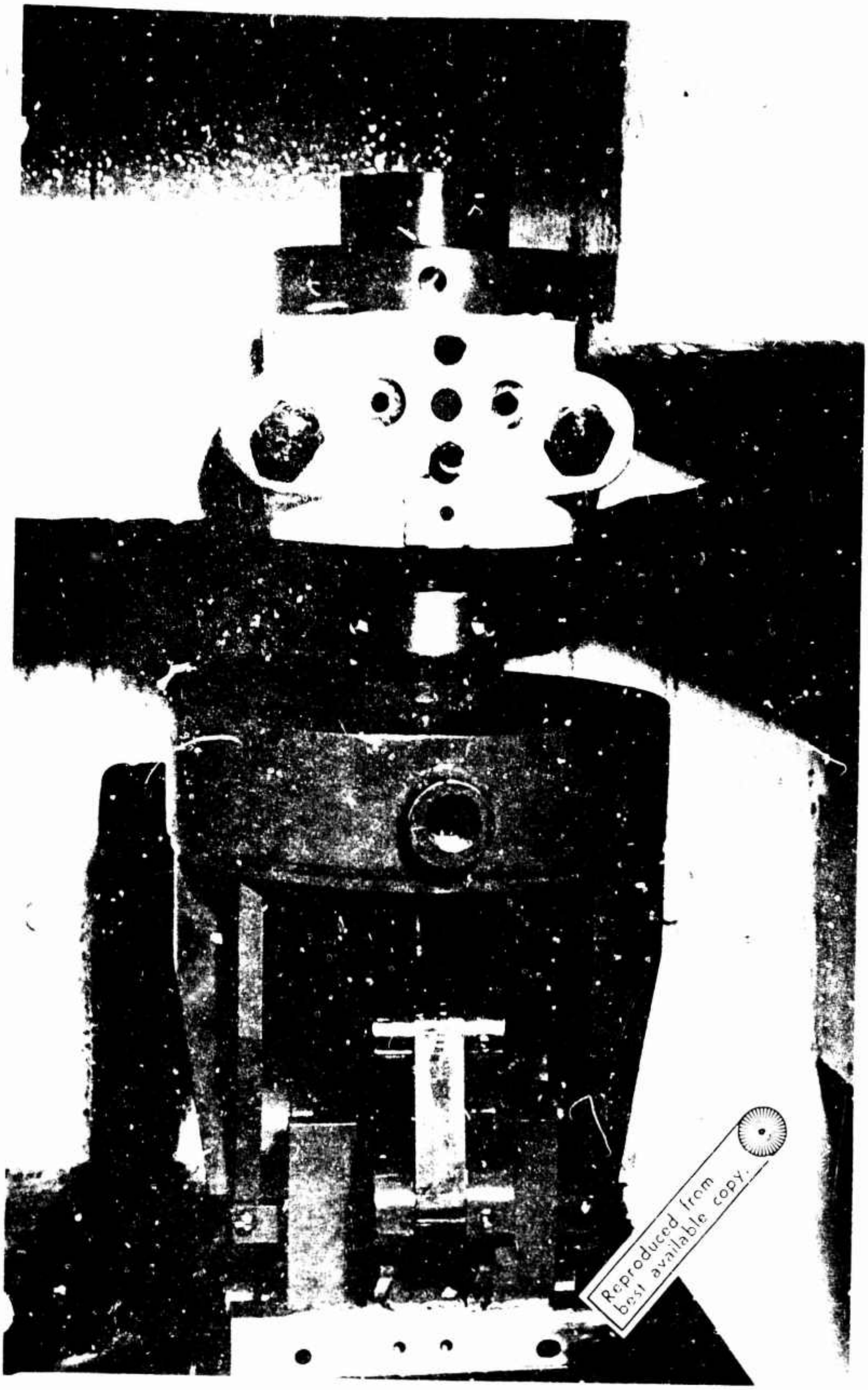

Figure D-7 Side View Of Sealing Head In 216 VOC Machine

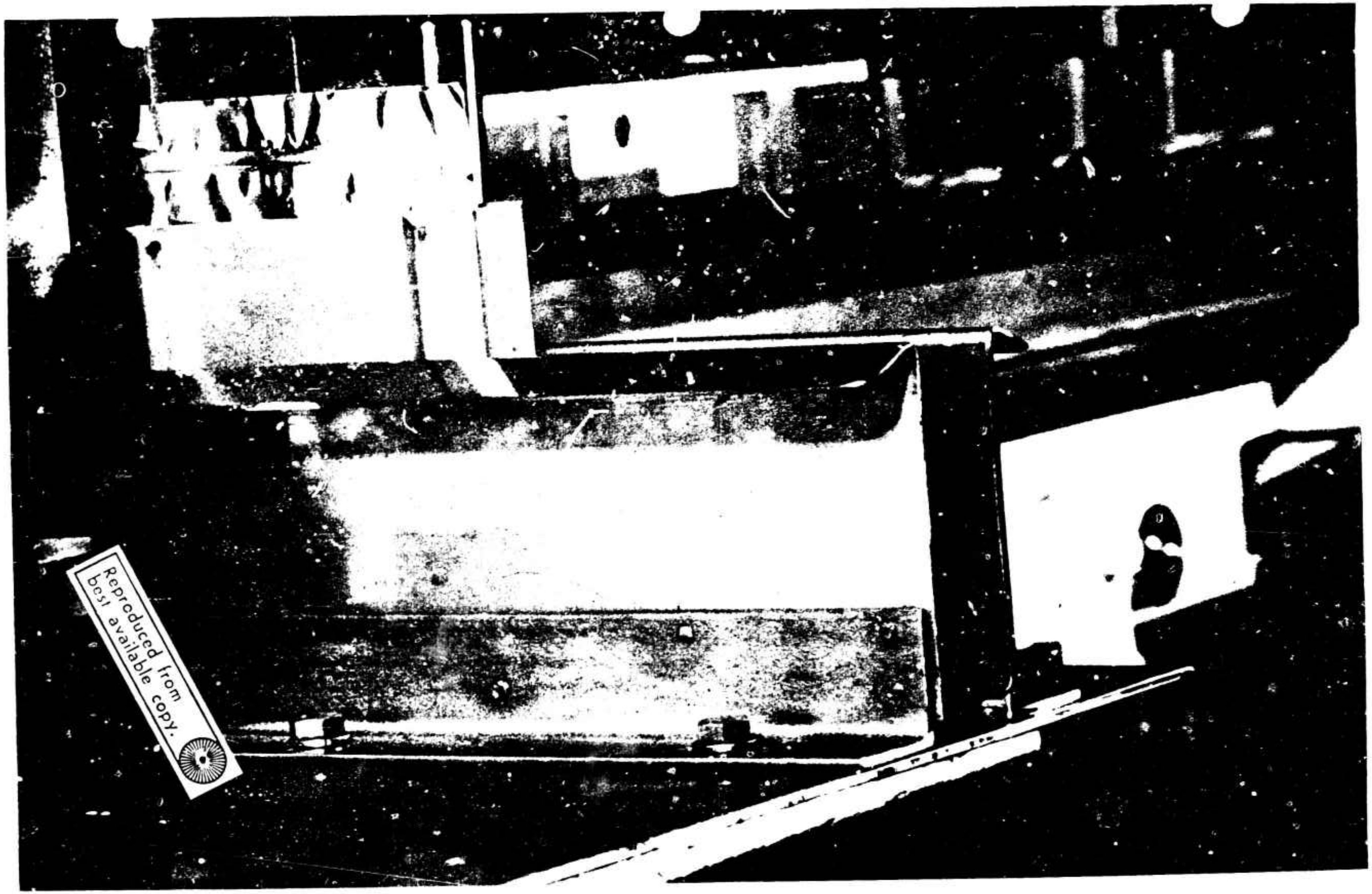

Figure D-8 View of Discharge of 216 VOC Machine

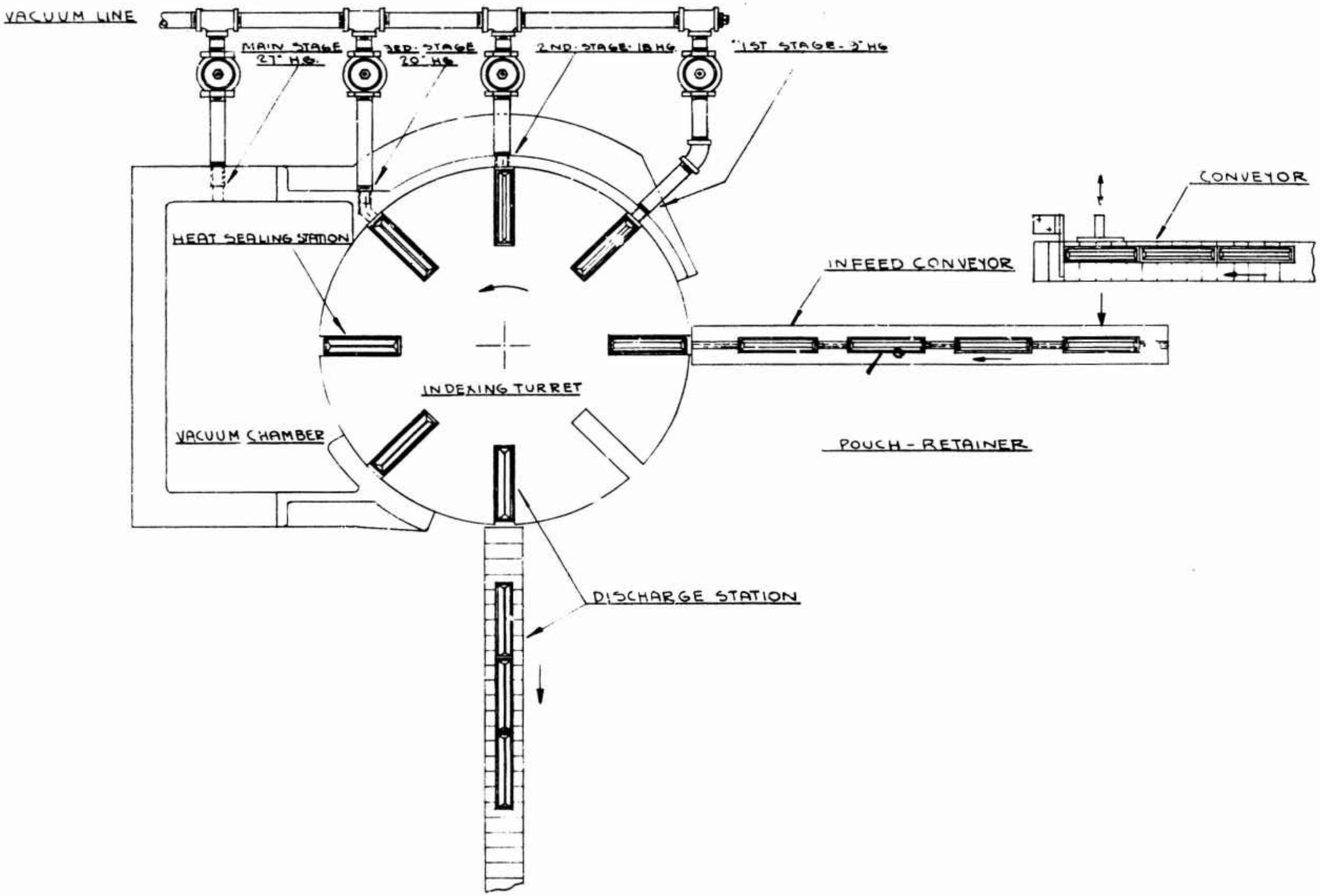

Figure D-9 Vacuumizing and Heat Sealing Module (216 VOC Machine)

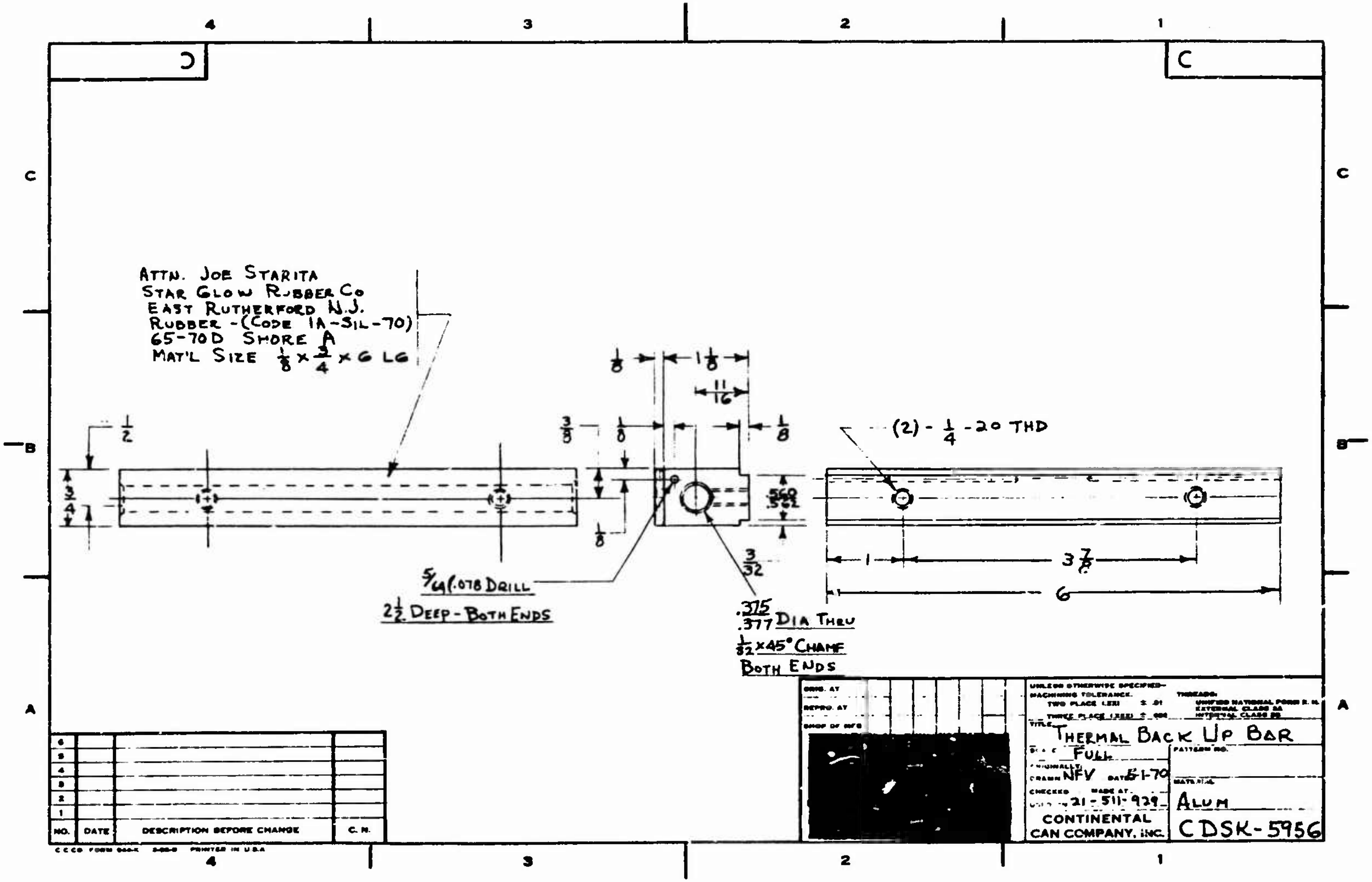

Figure D-10 Thermal Backup Bar

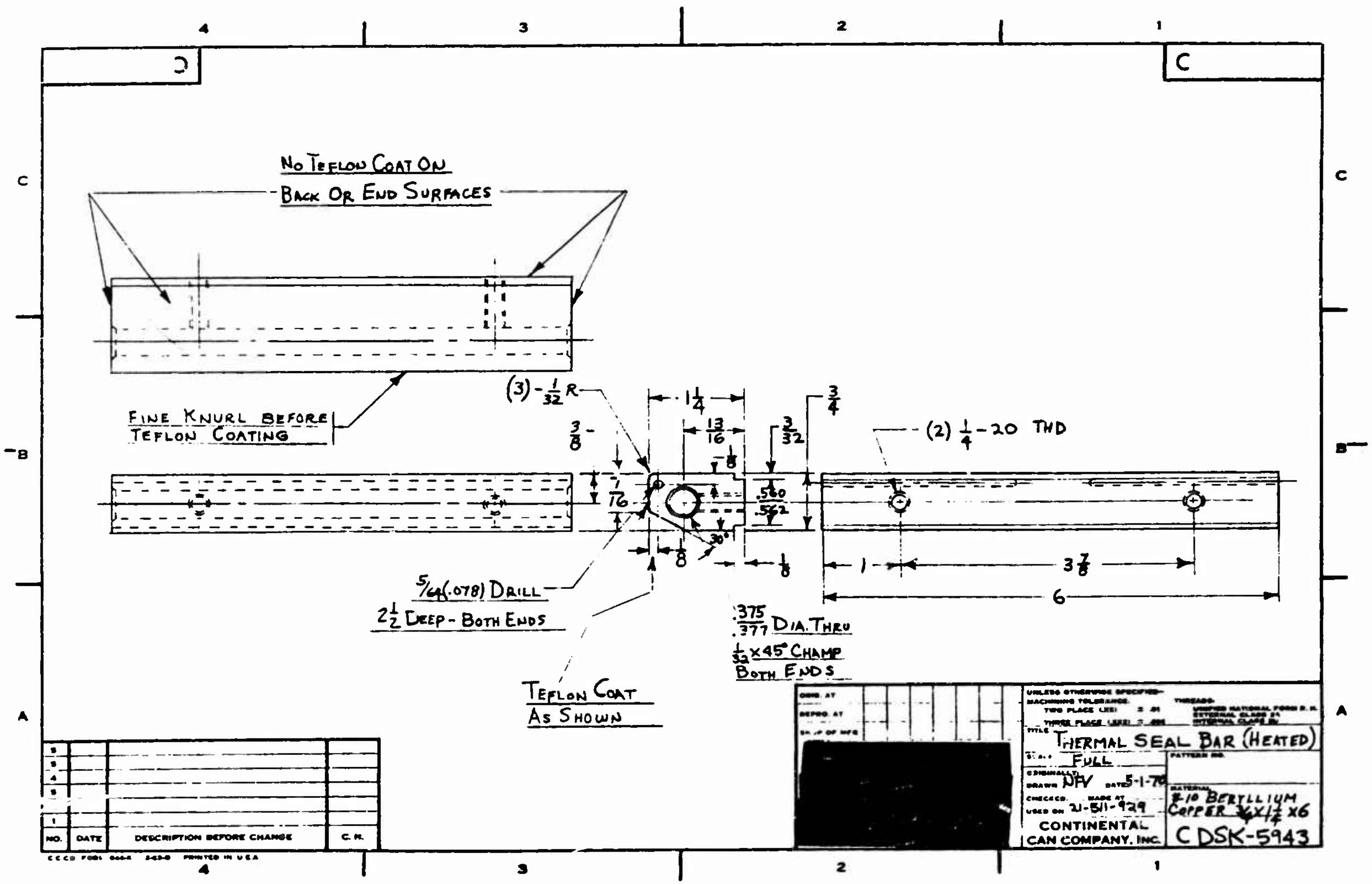

Figure D-11. Thermal Heat Bar

It is possible to seal through a modest amount of contamination by reducing the speed of the machine, but contamination in the seal will always yield visual evidence after sealing, rendering the package defective by the standards of this program. There is reason to believe that seals containing entrained contaminants may be usable in terms of all performance criteria other than visual inspection (see Task C).

Heat Seal Parameters

Thermal sealing was determined as the preferred method for this equipment. Considerable work has been done on this and other programs with impulse sealing (see Task C) which rapidly heats the seal area by means of an electrical resistance wire and then chills the seal after the current ceases to flow, allowing the seal to solidify before the jaws are released. Such a system has disadvantages in that it is more complex than the thermal unit and requires a longer cycle.

A test fixture was designed and built to thermal bar heat seal a filled pouch in a carrier.

The following features were incorporated in this fixture:

1. Variable temperature control on heat seal bars.
2. Variable pressure control on heat seal bars.
3. Variable time control on closure of heat seal bars.
4. A tensioning device for holding the seal area taut during heat sealing.

Many tests were run on this fixture in an effort to seal through controlled water contamination. Various heat seal bar configurations were tried as well as different thickness silicone rubber backup bars. Different temperatures and pressures were tried in addition to the above variables. We were able to obtain seals with "T" peel values of 15 to 16 lb/inch that would withstand a burst test of 25 pounds per square inch. However, we were not able to make seals that were visually free of contamination, and by the specifications set forth these pouches are defective, even though they pass the "T" peel and burst tests.

Noncontaminated pouches were heat sealed as a control unit in the tests, and it is readily apparent that with proper temperature, pressure, and dwell time a seal can be made that will meet specifications (see Task C).

The contract calls for contamination-free filling, and subsequent development effort indicated this is feasible. The tests performed on the bench model sealing fixture explored the possibility of further assurance of good seals in the event accidental contamination did occur. These tests also establish the necessary parameters for all seal bar combinations. Since contamination-free filling is the criteria, the recommended bar

configurations are DSK-5956 (Fig D-10) for the heated bar and DSK-5943 (Fig D-11) for the back-up bar. It should be recognized that further evolution of seal bar configuration is possible.

Figure D-10	Thermal Backup Bar
Figure D-11	Thermal Heat Bar
Figure D-12	Side View of Bench Model Vacuum Chamber and Test Seal Fixture
Figure D-13	Top View of Bench Model Vacuum Chamber and Test Seal Fixture
Figure D-14	View of Test Seal Fixture Removed from Vacuum Chamber
Figure D-15	Side View of Test Seal Fixture
Figure D-16	Side View of Test Seal Fixture with Pouch and Carrier

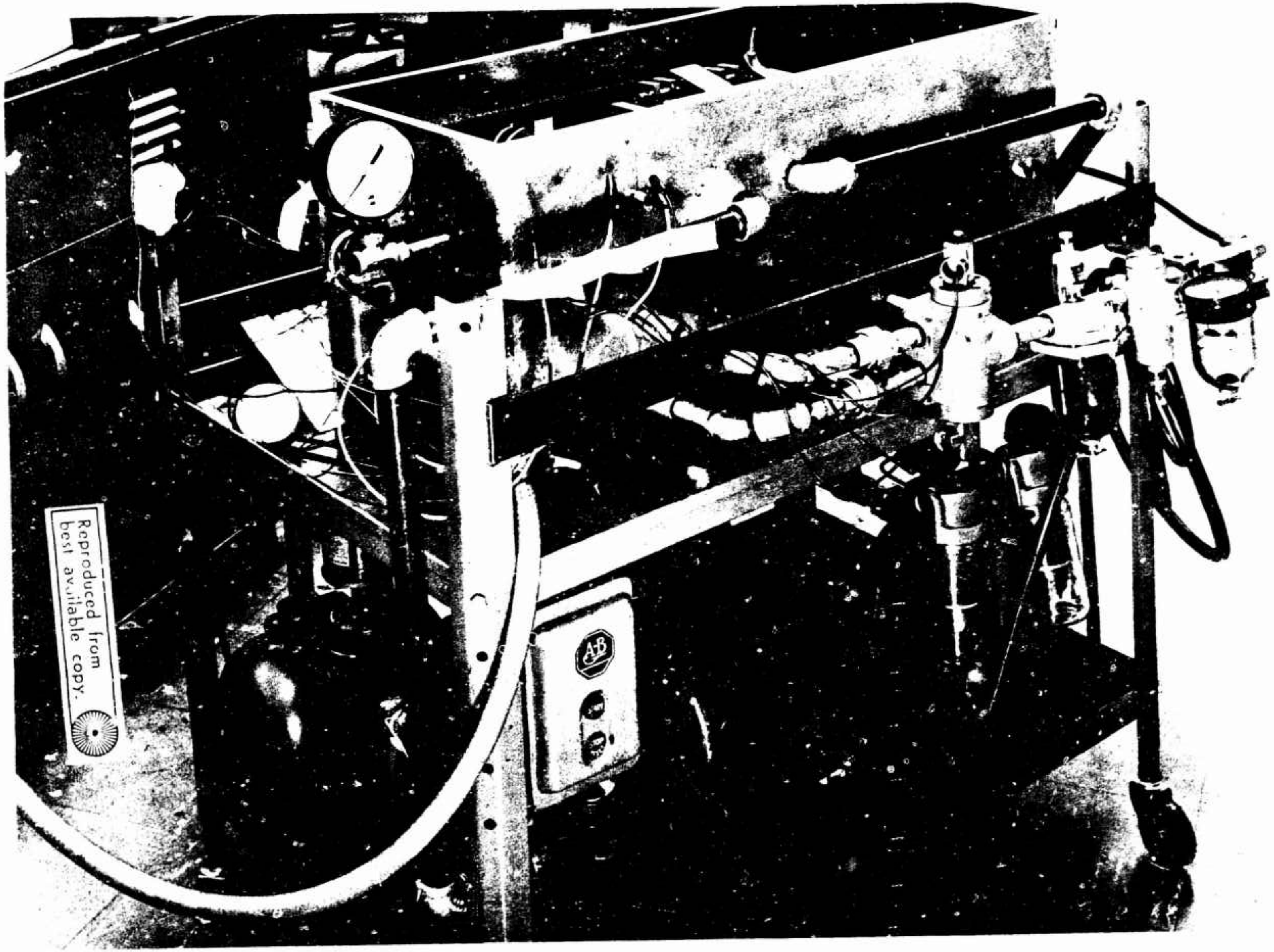

Figure D-12 Side View Of Bench Model Vacuum Chamber Enclosing The Test Seal Fixture

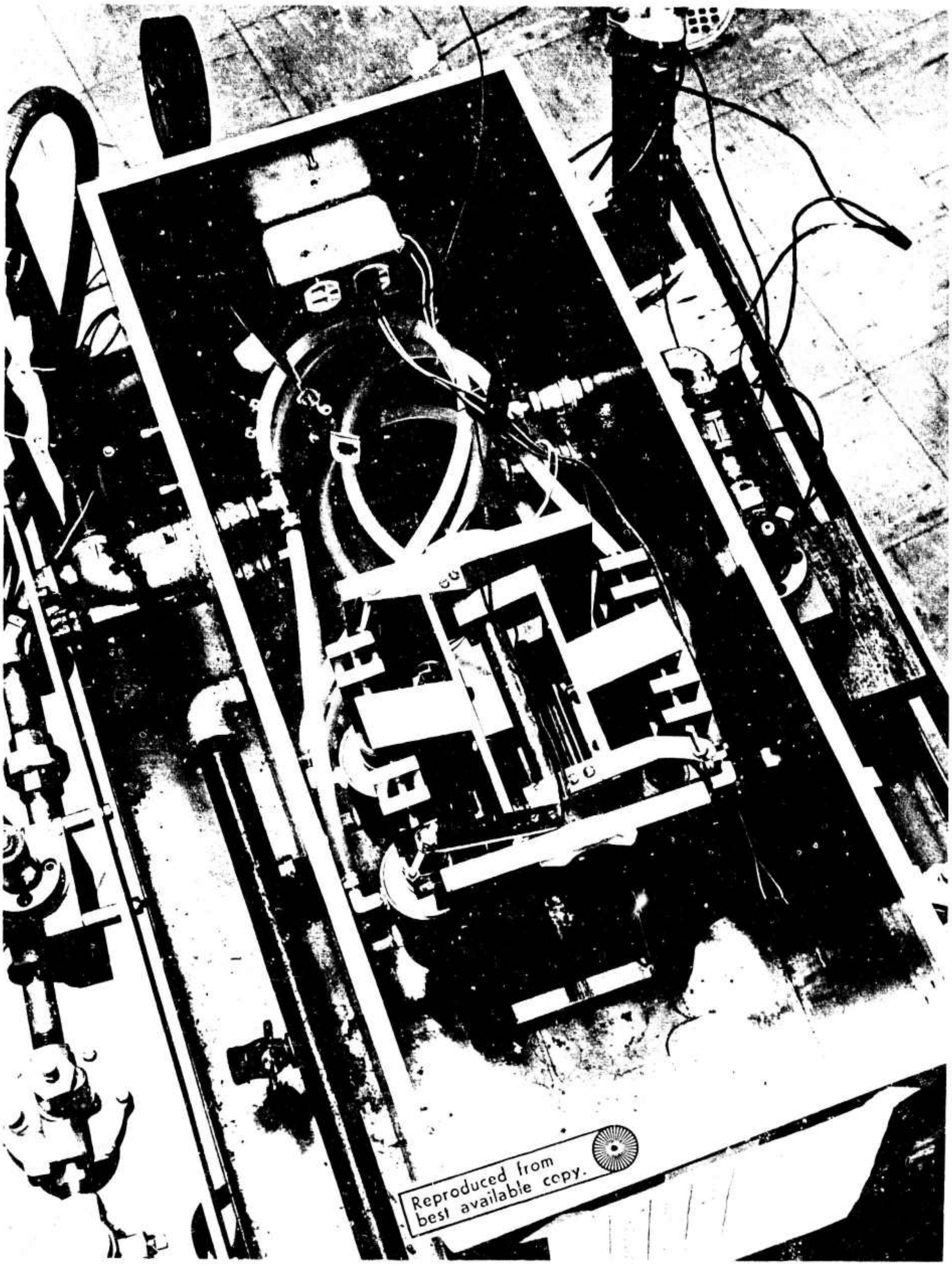

Figure D-13 Top View Of Bench Model Vacuum Chamber and Test Seal Fixture

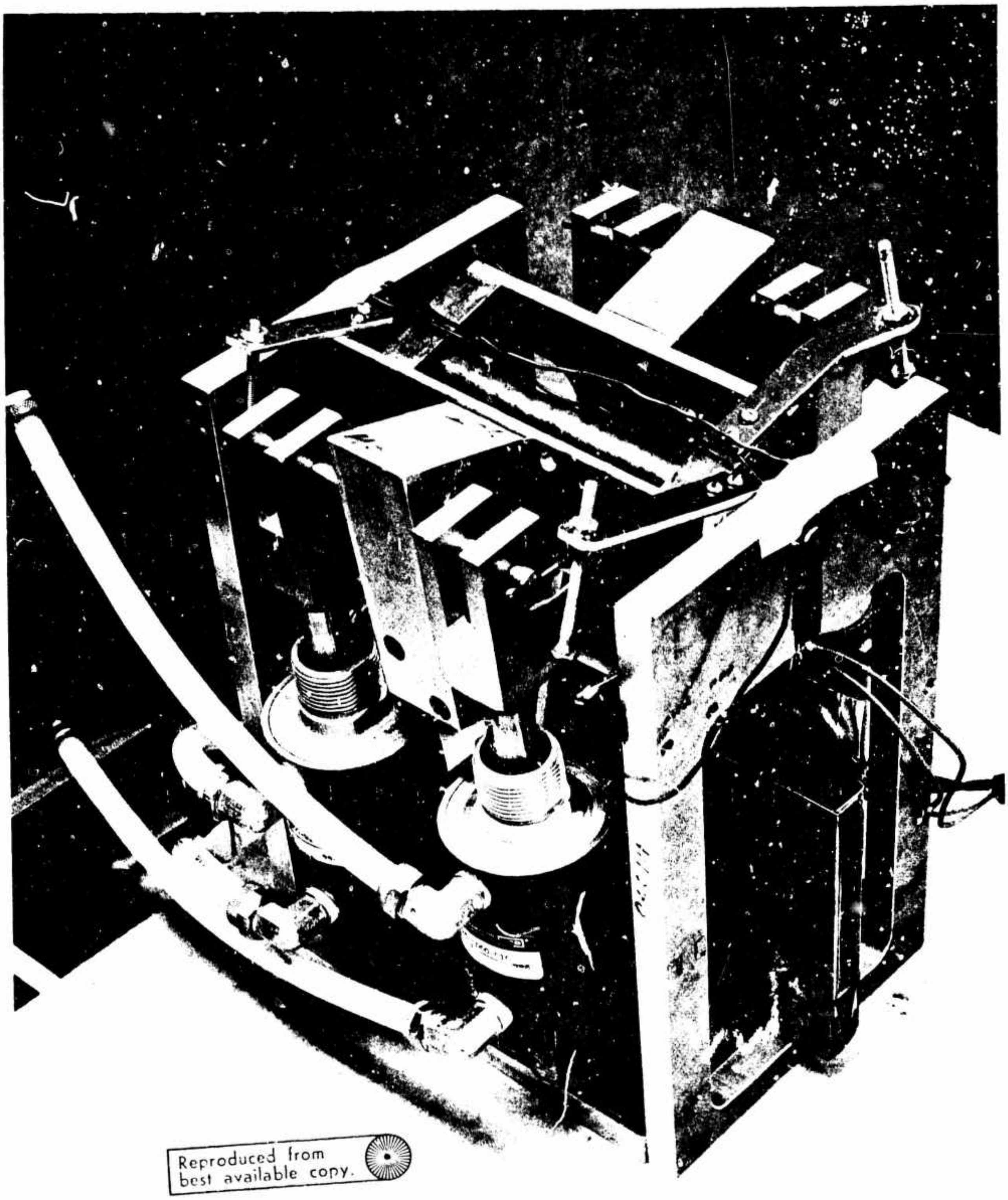

Figure D-14 View Of Test Seal Fixture Removed from Vacuum Chamber

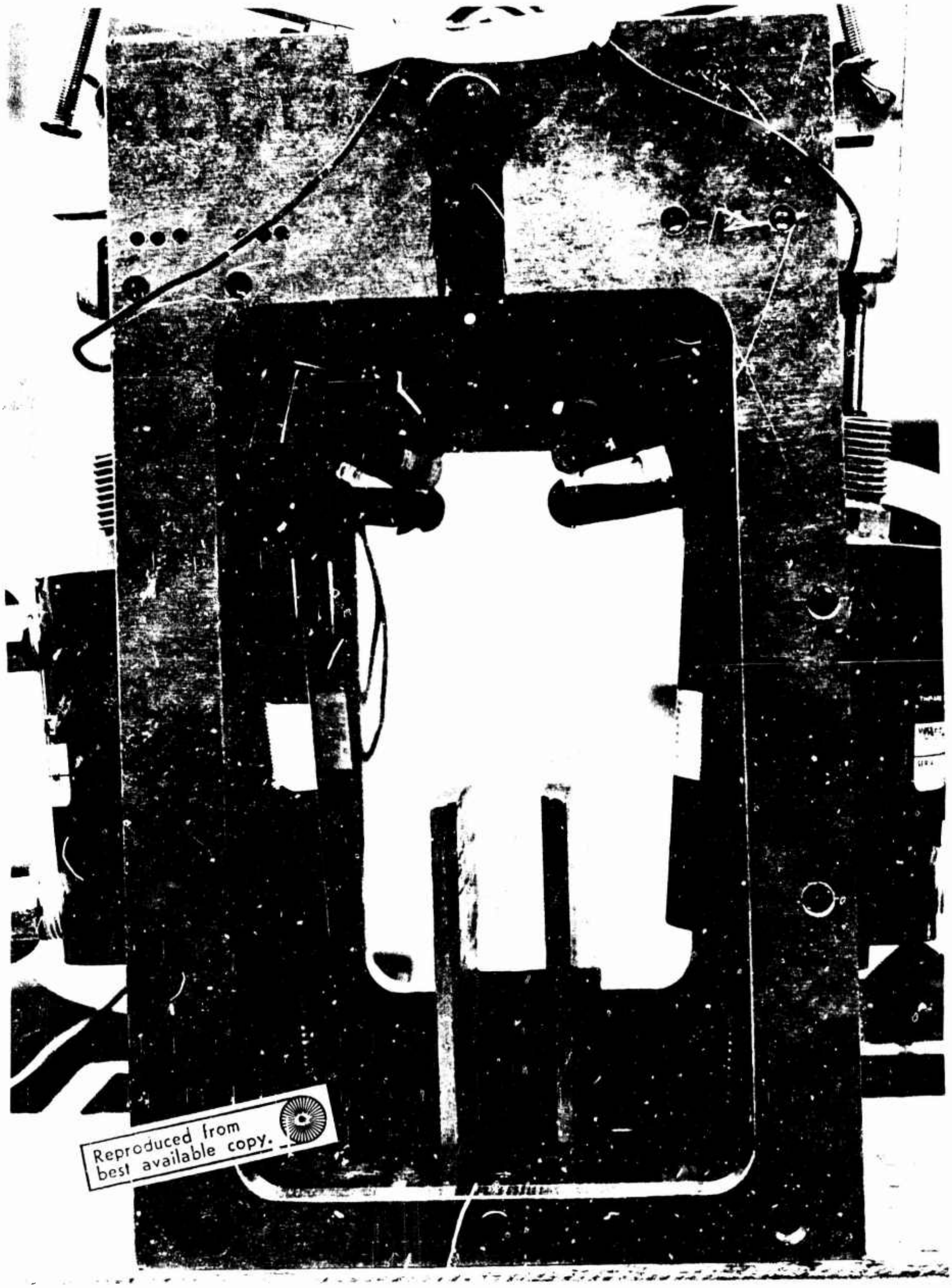

Figure D-15 Side View of Seal Test Fixture

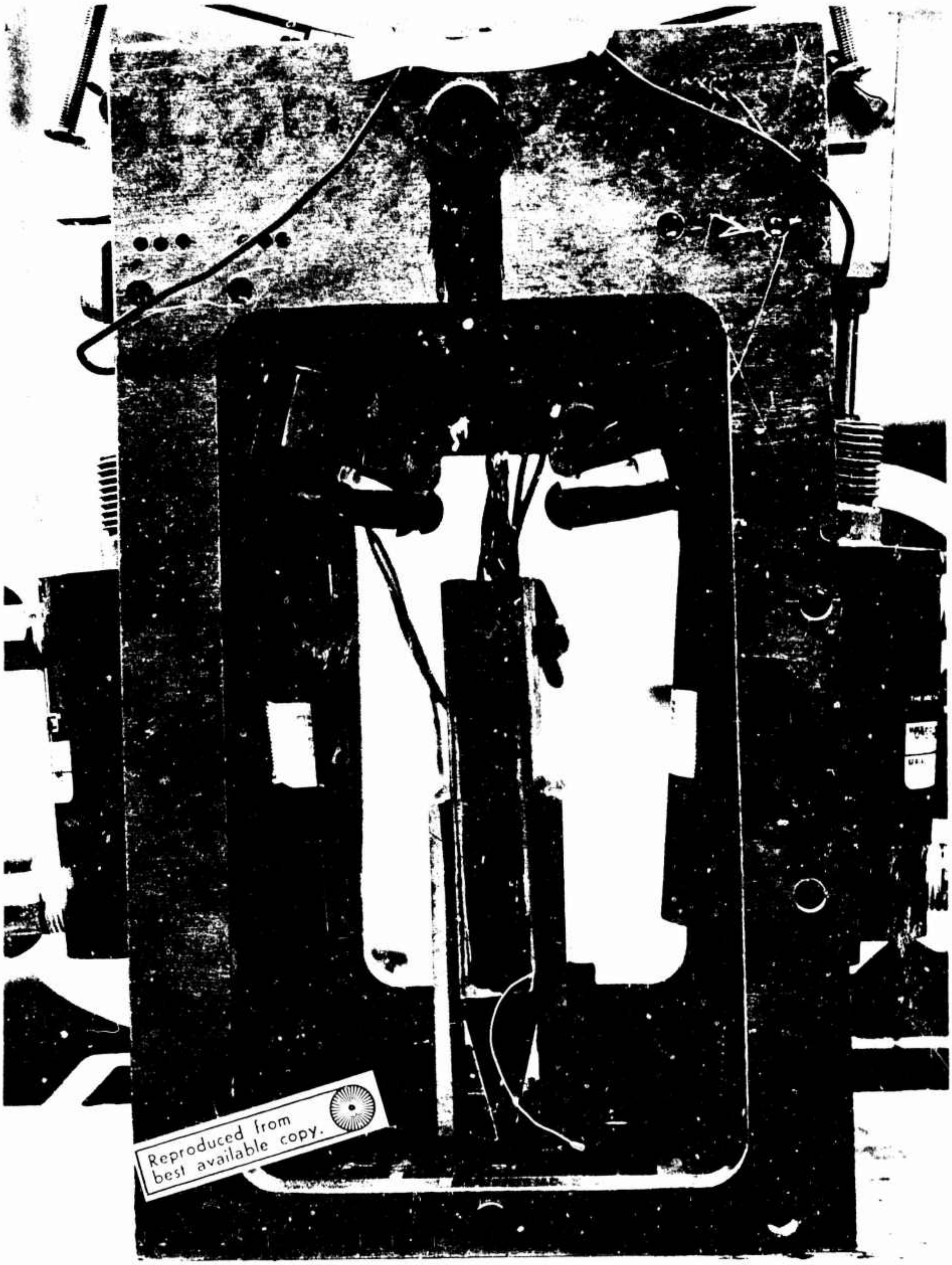

Figure D-16 Side View of Seal Test Fixture with Pouch and Carrier

Task DD Technical Feasibility Of The Filling And Package Forming System

The objective of this task was to establish the feasibility of reliably

1. automatically producing a pouch with one bottom and two side heat seals at a production rate of sixty pouches per minute.

2. incorporating an easy opening notch cut-out on these pouches.

3. automatically or semiautomatically filling these pouches with pumpable, extrudable, and placeable food items without contamination of the top final seal areas. (See Table DD-1).

The packaging material was a laminate of 0.5-mil polyester, 0.35-mil aluminum foil, and 3-mil polyolefin. Bench model testing or analytical studies could be used. Filling test criteria was a mean production rate of thirty pouches per minute or greater for all products, with an operational goal of sixty per minute for pumpable products.

A reliable heat sealing and temperature control system and a pouch notching unit to meet the pouch making objectives of this task has been developed.

It is recommended that the pouch making method described in Table DD II Pouch Making Method be used in the production phases of this contract. Three commercial food product filling devices were successfully modified; one food product filling device and three food product dispensing nozzles were developed to reliably perform to the objectives of this task.

The product filler and dispensing nozzle combinations as described in Table DD III, Product Filling Methods, are recommended for use in the production phase of this contract.

The pouch making and product filling methods were successfully combined on a specially equipped Bartelt Engineering horizontal pouch packaging machine to perform to the objective of this task.

The Bartelt Engineering packaging machine described in Table DD IV, Recommended Production Phase Packaging Machine, is recommended for use in the production phase of this contract. This is projected to require six to eight months to engineer, manufacture, ship, and assemble the packaging machine rather than the six months as originally proposed. An additional one to two months may be required for "shakedown" of this equipment prior to production runs.

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TABLE DD I

FOOD ITEM CLASSIFICATION

Item	Classification
Barbecue Sauce*	Pumpable
Beans in Tomato Sauce	Pumpable
Beef Stew, Vegetables & Gravy**	Pumpable
Bread	Pumpable
Chicken Ala King	Pumpable
Chocolate Nut Cake	Pumpable
Fruit Cake	Pumpable
Orange Nut Cake	Pumpable
Ground Beef With Pickle Flavored Sauce	Pumpable
Pineapple In Syrup	Pumpable
Pound Cake	Pumpable
Beef Loaf	Extrudable
Chicken Loaf	Extrudable
Ham and Chicken Loaf	Extrudable
Beef Slices*	Placeable
Beef Steak	Placeable
Beef Stew, Meat**	Placeable
Frankfurters	Placeable
Pork Sausages	Placeable

* Combined for beef slices in barbecue sauce.
** Combined for beef stew.

TABLE DD II

POUCH MAKING METHOD

Machine Speed: 30 to 60 Pouches per Minute

Pouch Size: See Figure C5.

Bottom Heat Seal: See Figure DD13.

Dwell Time:	0.5 seconds
Silicone Rubber:	1/16", Grade FR-132 50 Durometer
Teflon Cloth:	3-Mil Thick, 0.18 lb/yd^2
Temperature Controller:	API Model 227
Thermocouple:	Glesco Model 121
Heat Seal Bar, Rear:	Figure DD 8.
Seal Bar Material:	Aluminum, Grade 2024-T4
Plug:	Figure DD 6
Cartridge Heater:	Watlow, 1,000 watt, 240 volt, 3/4" dia. x 7" long
Watt Density:	410 watts/in.^{2}
Operating Temperature Setting:	425°
Heat Seal Bar, Front:	Figure DD 7 – 3
Seal Bar Material:	Stainless Steel, Grade 17–4 PH
Plug:	Figure DD 6.
Spring:	1" Lg. (Cut from Danly 9-1216-31)
Cartridge Heater:	Watlow, 500 watt, 240 volt, 3/4" dia. x 7" long.
Watt Density:	205 watts/in.^{2}
Operating Temperature Setting:	300°F.
Seal Pressure:	185 lb/in.^{2}
Bottom Seal Cooling Assembly	
Dwell Time:	0.5 seconds
Operating Temperature Setting:	50°F. maximum

Side Heat Seal: See Figure DD-12

Dwell Time:	0.5 seconds
Silicon Rubber:	1/16", Grade FR-132 50 Durometer
Teflon Cloth:	3-Mil thick, 0.18 lb/yd^2

TABLE DD II (Cont'd)

POUCH MAKING METHOD

Side Heat Seal: (Cont'd)

Temperature Controller:	API Model 227
Thermocouple:	Glesco Model 121
Heat Seal Bar, Rear:	Figure DD 3.
Seal Bar Material:	Aluminum, Grade 2024-T4
Plug:	Figure DD 6
Cartridge Heater:	Watlow, 2,000 watt, 240 volt, 3/4"dia. x 12" long
Watt Density:	378 watts/in^2
Operating Temperature Setting:	475° F.
Heat Seal Bar, Front:	Figure DD 2 – 4
Seal Bar Material:	Stainless Steel, Grade 17-4 PH
Plug:	Figure DD 6.
Spring:	1" Lg. (Cut from Danly 9-1216-31)
Cartridge Heater:	Watlow, 1,000 watt, 240 volt, 3/4" dia. x 12" long.
Watt Density:	188 watts/in^2
Operating Temperature Setting:	450°F.
Seal Pressure:	185 lb/in^2

Side Seal Cooling Assembly

Dwell Time:	0.5 seconds
Operating Temperature Setting:	50°F. maximum

Notcher Assembly:	To form notch per Fig. C5.

Photo Electric Scanner Assembly:

Photo Registration Mark on Material.
Must be of white color. Registration must be printed in accordance with Riegel Packaging Machine specifications.

TABLE DD III

PRODUCT FILLING METHODS

PRODUCT	FILLING METHOD	DISPENSING NOZZLE
Beans In Tomato Sauce	Bock Piston (Modified) Figure DD 21.	1" Dia. Plunger Figure DD 27.
Beef Stew	(Vegetables & Gravy) Bock Piston (Modified) Figure DD 21.	1" Plunger Figure DD 27.
	(Meat) Placeable Figure DD 31.	None
Chicken Ala King	Bock Piston (Modified) Figure DD 21.	5/8" Dia. Plug Figure DD 26.
Chocolate Nut Cake	CP Stuffer Figure DD 22.	Rotary Valve Figure DD 28.
Fruit Cake	CP Stuffer Figure DD 22.	Rotary Valve Figure DD 28.
Orange Nut Cake	CP Stuffer Figure DD 22.	Rotary Valve Figure DD 28.
Ground Beef With Pickle Flavored Sauce	Bock Piston (Modified) Figure DD 21.	5/8" Dia. Plug Figure DD 26.
Pineapple in Syrup	Bock Piston (Modified) Figure DD 21.	5/8" Dia. Plug Figure DD 25.

TABLE DD III (Cont'd)

PRODUCT FILLING METHODS

PRODUCT	FILLING METHOD	DISPENSING NOZZLE
Pound Cake	CP Stuffer Figure DD 22.	Rotary Valve Figure DD 28.
Beef Loaf	Bartelt Model D Figure DD 23.	Sliding Tube Figure DD 23.
Bread	CP Stuffer Figure DD 22.	Rotary Valve Figure DD 28.
Chicken Loaf	Bartelt Model D Figure DD 23.	Sliding Tube Figure DD 23.
Ham & Chicken Loaf	Bartelt Model D Figure DD 23.	Sliding Tube Figure DD 23.
Beef Slices in Barbecue Sauce	(Sauce) Bock Piston (Modified) Figure DD 21.	5/8" Dia. Plug Figure DD 26.
	(Slices) Placeable Figure DD 31.	None
Beef Steaks	Placeable Figure DD 31.	None
Frankfurters	Placeable Figure DD 31.	None
Pork Sausages	Placeable Figure DD 31.	None

TABLE DD IV

RECOMMENDED PRODUCTION PHASE PACKAGING MACHINE

One Bartelt Engineering Model P9-11 special horizontal pouch packaging machine complete to perform the following automatic sequence of operations from a minimum speed of thirty to a maximum speed of sixty pouches per minute:

1. Form the pouch as shown in Figure C-5 producing two side and one bottom heat seal and a pouch easy opening notch cut-out.

2. Transfer the formed pouch to the bag clamp conveyor for pouch opening, subsequent product filling, and pouch top presealing if required.

3. Provide the necessary product filling and dispensing nozzles shown in Table DD III to accurately fill the seventeen products listed in Table DD I.

4. Position the filled pouch at the final station on the packaging machine and provide for opening of the bag clamps at this station to release the pouch.

Additional Equipment Provided:

1. Powered web roll arbor

2. Automatic web edge guiding

3. Refrigeration unit for cooling bars

4. Photo electric scanner assembly

5. Special teflon cloth indexing device (development)

6. No pouch – no fill electric detector

7. Electrical time delay heat control system

Machine will be constructed, where practical, to operate in a wash down type atmosphere.

Test Machinability of Laminate

This area of study was an evaluation of all the variables involved in producing a pouch from the packaging material to achieve the high degree of reliability stated in this contract. It included an evaluation of the packaging material for damage during pouch forming, design of heat sealing bars, pouch notch cut-out and heat seal cooling bars, selection of cartridge resistance heating elements, a temperature control system, and an evaluation of the finished pouch for heat seal and pouch burst strength.

1. Foil Pinhole Analysis Test

The packaging material was subjected to a foil pinhole analysis test to detect material damage during pouch forming. Pinholes in foil material of the specified thickness of these pouches are normal, unavoidable, and acceptable unless excessive.

The amount of foil pinholing was determined by examining a test length (10 feet by 14-1/2 inches wide) of new packaging material over a flourescent lighted box in a darkened room and recording the number and location of all foil pinholes present in the sample. The test material was then advanced through the machine as shown in Figure DD 1 and re-examined using the lighted box technique. Heat seals and pouch notch cut-out were omitted so the material could be unfolded for inspection.

The results of two separate tests are presented in Table DD V. Significantly, all foil pinholes created by pouch forming were located in the bottom fold area of the pouch which is also the bottom-most portion of the pouch bottom seal. It is our opinion that the presence of foil pinholes in this location will not detract from the quality of finished pouches. Although we were unable to measure the diameter of any foil pinholes, all were of very minute size. No other defects were detected. Pinholing of other laminate layers was not checked.

2. Design of Heat Sealing Bars

The heat sealing specifications established and provided by Task C included determining the operating temperature setting for each heat sealing bar, developing heat sealing bars which would maintain a maximum temperature variation of no more than ± 10°F. along the sealing surface of each during operation and establishing a machine temperature control system to maintain this temperature uniformity within a temperature range of 250° to 600°F.

Four sealing bar materials, six side seal, and three bottom seal heat sealing bar cross section designs, four brands of commercial cartridge resistance heating elements, and two cartridge heater hole sizes were evaluated in developing reliable side and bottom heat sealing bars which conformed to the required specifications.

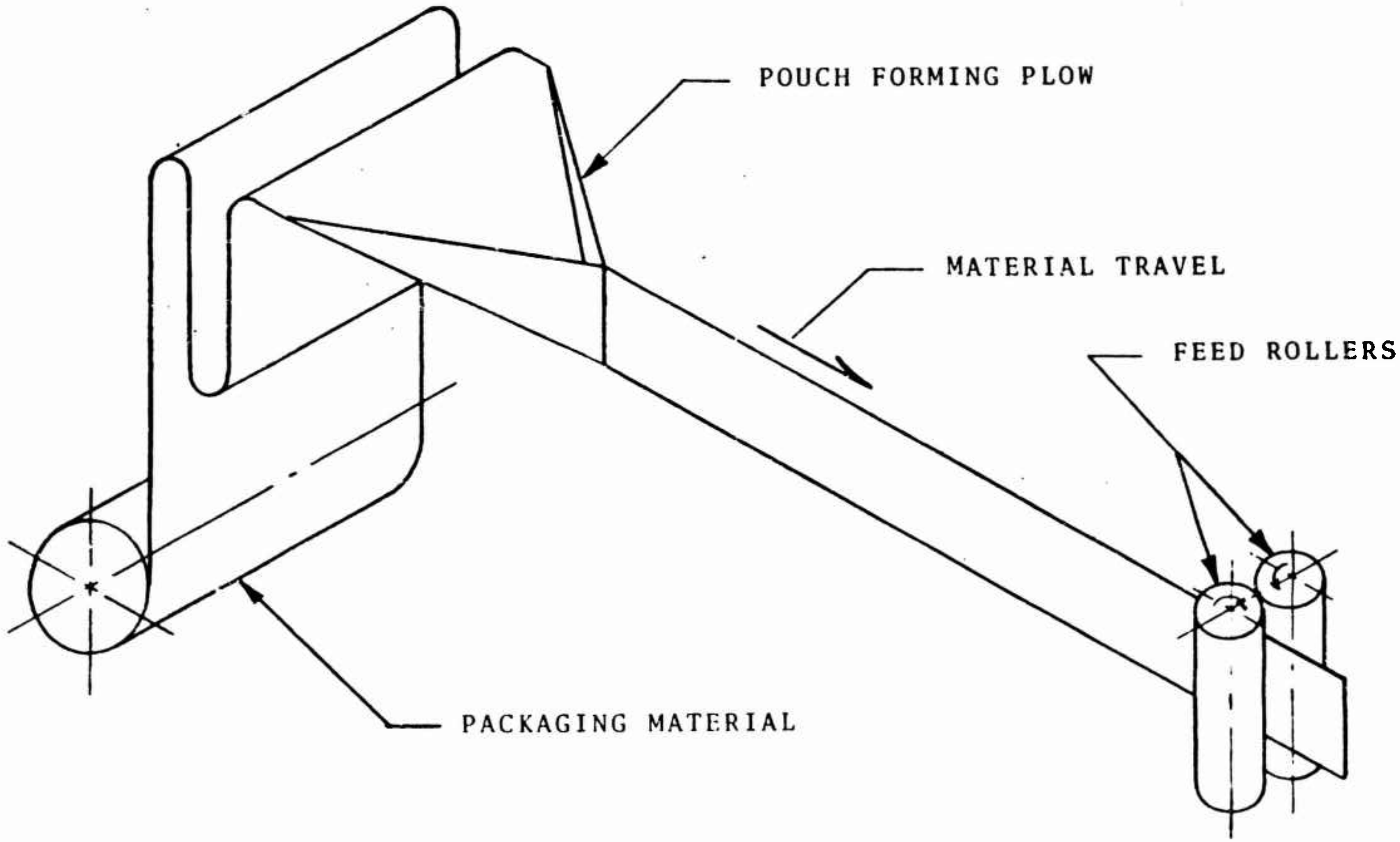


FIGURE DD 1   SCHEMATIC DRAWING OF POUCH FORMING

TABLE DD V

RESULTS OF FOIL PINHOLE ANALYSIS TEST

Test No.	Number of Foil Pinholes Prior To Pouch Forming*	Number of Foil Pinholes After Pouch Forming	Number of Foil Pinholes Resulting From Pouch Forming
1	96	101	5
2	128	134	6

* Lenth of web inspected: 10 feet. Width of web inspected: 14-1/2 inches.

2. Design of Heat Sealing Bars (Cont'd)

The operating temperature settings for each heat sealing bar, determined by experimentation, are listed in Table DD II. The machine temperature control system is described in detail later in this report.

The following materials were investigated for side heat sealing bars, not only for temperature uniformity, but for durability and for resistance to heat warpage and corrosion:

a) Mechanite, Grade GE
(Configurations tested Figure DD 2 –1, –2, –3, & –5)
b) Stainless Steel Grade 17-4PH
(Configurations tested Figure DD 2 –4),
c) Aluminum, Grade 7075-T6
(Configurations tested Figure DD 2 –5)
d) Aluminum, Grade 2024-T4
(Configurations tested Figure DD 2 –6)

The six side heat seal bar cross section designs evaluated are shown in Figure DD 2 and identified as –1 through –6.

Configuration DD 2-1 is the heat sealing bar used on a standard Bartelt Engineering form/fill/seal machine.

Configuration DD 2-3 was an improvement to seal bar design DD 2-1 by adding more material adjacent to the heat sealing surface.

Configuration DD 2-3 was a modification to bar DD 2-2.

Configurations DD 2-4 and DD 2-5 are designs with increased bar thickness to position more material between the cartridge heater and the sealing surface of the bar and provide an improved location for the temperature control thermocouple probe.

Configuration DD 2-6 was constructed using the same thickness as bars DD 2-1, 2 & 3 and incorporates the additional material adjacent to the sealing surface.

A test side seal bar constructed from aluminum, Grade 2024-T4, using Configuration Design DD 2-6, was successful in meeting the operating temperature setting ± 10°F. maximum temperature variation specification, when located in the rear side heat sealing position during operating conditions using the temperature control system described later in this report. A steel backing plate has been attached to the rear of this seal bar to provide a more durable bar mounting surface. We recommend that the aluminum bar, Figure DD 3, which is acceptable for corrosion resistance and resistance to heat warpage, be used in the rear side heat sealing position in the next phase of this program. See Figure DD 4 for a successful temperature mapping of this side seal bar.

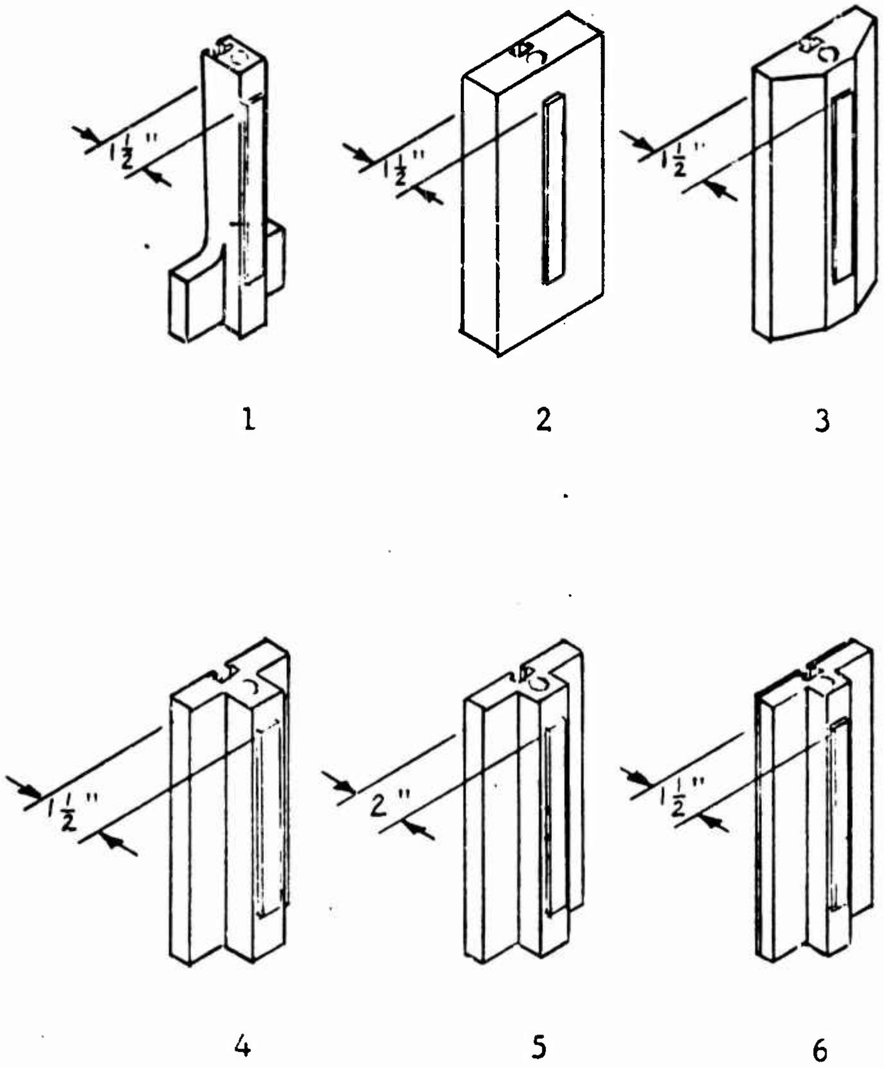


FIGURE DD 2. SIDE HEAT SEALING BAR CONFIGURATIONS

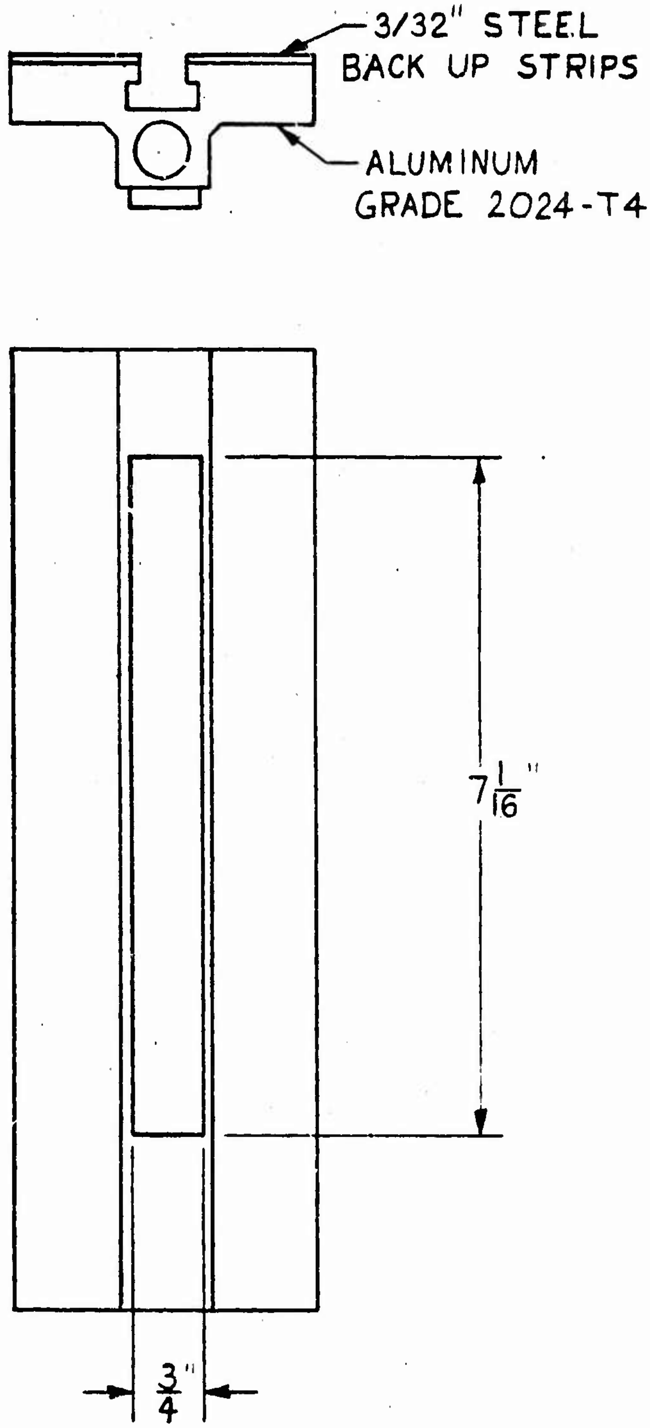


FIGURE DD 3. SIDE HEAT SEALING BAR

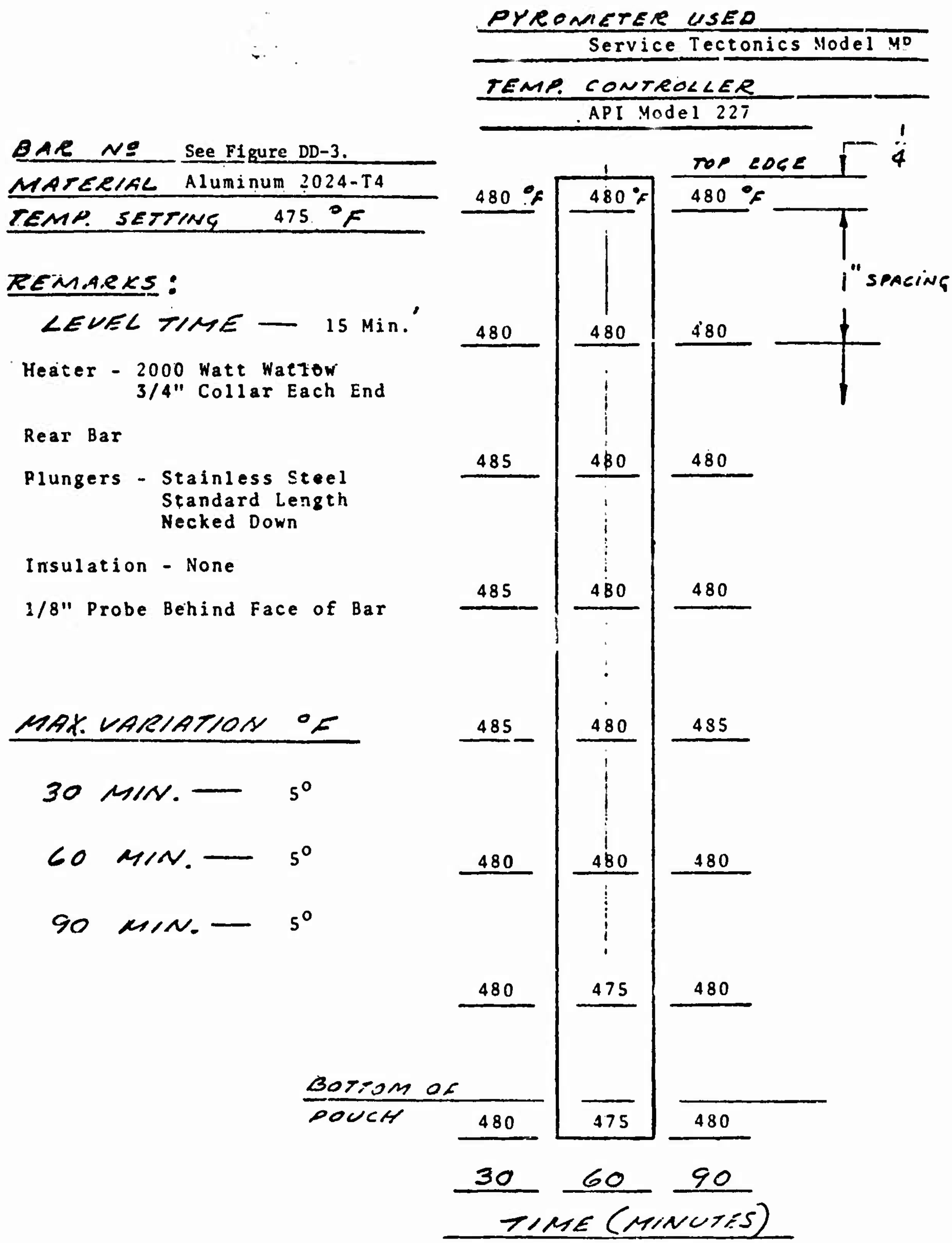


Figure DD-4. TEMPERATURE MAPPING -- SIDE SEAL BAR.

2. Design of Heat Sealing Bars (Cont'd)

Time did not permit us to determine the durability of an aluminum Grade 2024-T4 side heat sealing bar. We therefore recommend that the stainless steel Grade 17-4PH seal bar described below be used in the front side heat sealing position opposite the aluminum seal bar and that an extra aluminum Grade 2024-T4 side seal bar be supplied as a production safety factor.

A test side seal bar constructed from stainless steel Grade 17-4PH was unsuccessful in meeting the operating temperature setting ± 10°F. maximum temperature variation specification, when located in the rear side heat sealing position during operating conditions, using the temperature control system described later in this report. Upon repositioning this stainless steel seal bar in the front side heat sealing position, at a slightly reduced temperature and behind a sheet of silicon rubber as described in the "Heat Sealing Methods" section contained later in this report, we were successful in meeting the operating temperature setting ± 10°F. maximum temperature variation specification for this heat sealing bar position during operating conditions, using the temperature control system described later in this report. We recommend this stainless steel Grade 17-4PH heat sealing bar for the front side heat sealing station because of increased durability over the aluminum Grade 2024-T4 bar while still meeting the temperature uniformity requirements. The stainless steel bar is acceptable for corrosion resistance and resistance to heat warpage.

Commercial cartridge resistance heating elements from four different manufacturers were evaluated. These included elements from Acra, Ogden, Vulcan, and Watlow. Tests were conducted by placing the elements in the test heat sealing bars and adjusting the temperature controllers to various temperature levels and recording the temperature variation along the sealing surface of the sealing bars.

The elements were also tested prior to inserting them in the sealing bars by applying a voltage to the elements and recording the temperature variation along the element. See Figure DD 5 for a successful cartridge heater temperature mapping.

A single Watlow cartridge heating element produced the most uniform temperature distribution in the seal bars and is recommended for the production phase of this program.

Conduction heat losses from the seal bar into the rocker arm assembly supporting the seal bar were reduced by modifying the five steel plugs which position the seal bar adjacent to the rocker arm assembly. Although the quantity of heat loss was not determined, we were unable to obtain the ± 10°F. temperature variation until the plugs were modified as shown in Figure DD 6.

Bottom Seals

The two bottom heat sealing bar cross section designs evaluated are shown in Figure DD-7 and identified as "–1" and "–2".

PYROMETER USED

Service Tectonics Model MP

TEMP. CONTROLLER

Variable Transformer

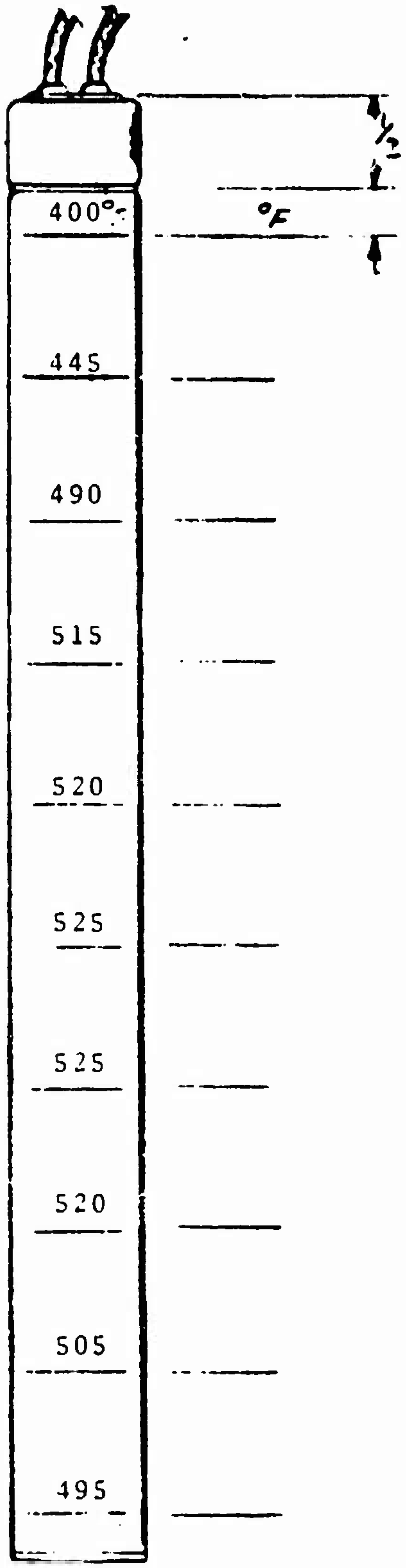
SETTING – 30%

HEATER SIZE	11-3/4"
WATTAGE	1000 Watt
BRAND NAME	Watlow
SHEATH MAT'L.	Stainless Steel
Max. Variation	125° F.

REMARKS

20 Minutes Level Time

#2 Heater



	TRIAL 1	TRIAL 2	TRIAL 3
1.	°F	400°F	°F
2.		445	
3.		490	
4.		515	
5.		520	
6.		525	
7.		525	
8.		520	
9.		505	
10.		495	
11.		470	
12.		430	

Figure DD 5. TEMPERATURE MAPPING -- CARTRIDGE HEATER.

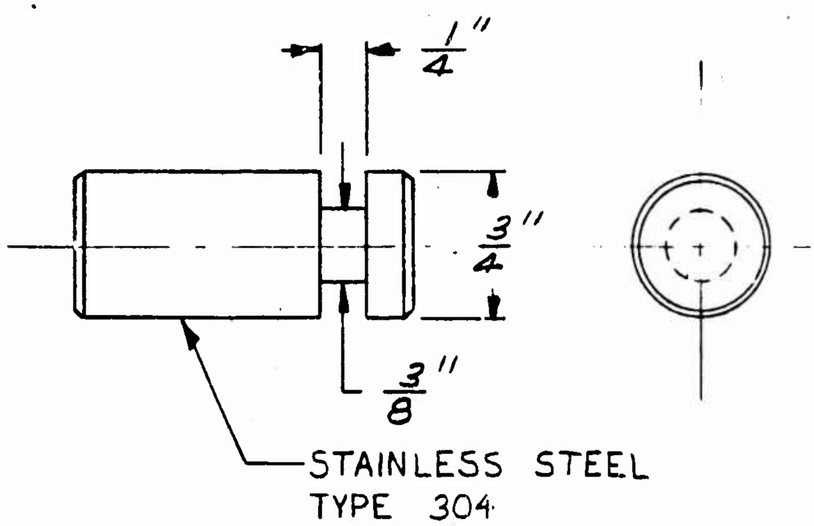


Figure DD 6. Heat Seal Positioning Plug Modified to Reduce Heat Conduction Loss.

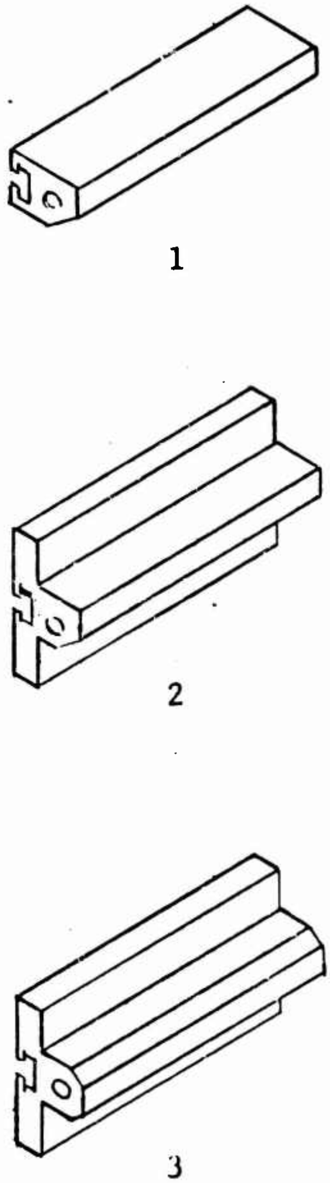


FIGURE DD 7. BOTTOM HEAT SEALING BAR CONFIGURATIONS

Configuration DD 7-1 is the heat sealing bar used on a standard Bartelt Engineering form/fill/seal machine.

Configuration DD 7-2 was an improvement to seal bar design DD 7-1 by adding more material adjacent to the sealing bar surface.

A test bottom seal bar constructed from aluminum, Grade 2024-T4, using Configuration Design DD 7-2, was successful in meeting the operating temperature setting ± 10°F. maximum temperature variation specification, when located in the rear bottom heat sealing position during operating conditions, using the temperature control system described later in this report. A steel backing plate has been attached to the rear of this seal bar to provide a more durable bar mounting surface. We recommend that the aluminum bar, Figure DD 8, which is acceptable for corrosion resistance and resistance to heat warpage be used in the rear bottom heat sealing position in the next phase of this program. See Figure DD 9 for a successful temperature mapping of this bottom seal bar. Configuration DD 7-3 is an improvement to seal bar design DD 7-2 by centering the sealing surface on the seal bar.

Time did not permit us to determine the durability of an aluminum Grade 2024-T4 bottom heat sealing bar. We therefore recommend that the stainless steel Grade 17-4PH seal bar, described below, be used in the front bottom heat sealing position opposite the aluminum seal bar and that an extra aluminum Grade 2024-T4 bottom seal bar be supplied in Phase II as a production safety factor.

A test bottom seal bar constructed from stainless steel Grade 17-4PH was unsuccessful in meeting the operating temperature setting ± 10°F. maximum temperature variation specification when located in the rear bottom heat sealing position during operating conditions, using the temperature control system described later in this report. Upon repositioning this stainless steel seal bar in the front bottom heat sealing position at a reduced temperature and behind a sheet of silicon rubber, as described in the "Heat Sealing Methods" section contained later in this report, it was successful in meeting the operating temperature setting ± 10°F. maximum temperature variation specification for this heat sealing bar position during operating conditions, using the temperature control system described later in this report. We recommend this stainless steel Grade 17-4PH heat sealing bar for the front bottom heat sealing station because of increased durability over the aluminum Grade 2024-T4 bar, while still meeting the temperature uniformity requirements. The stainless steel bar is acceptable for corrosion resistance and resistance to heat warpage.

Our experiments have shown that a 0.001-inch oversize cartridge heater hole is an improvement over our standard 1/64-inch oversize heater hole in achieving the temperature uniformity specification. We recommend the 0.001-inch oversize hole for the production phase of this program.

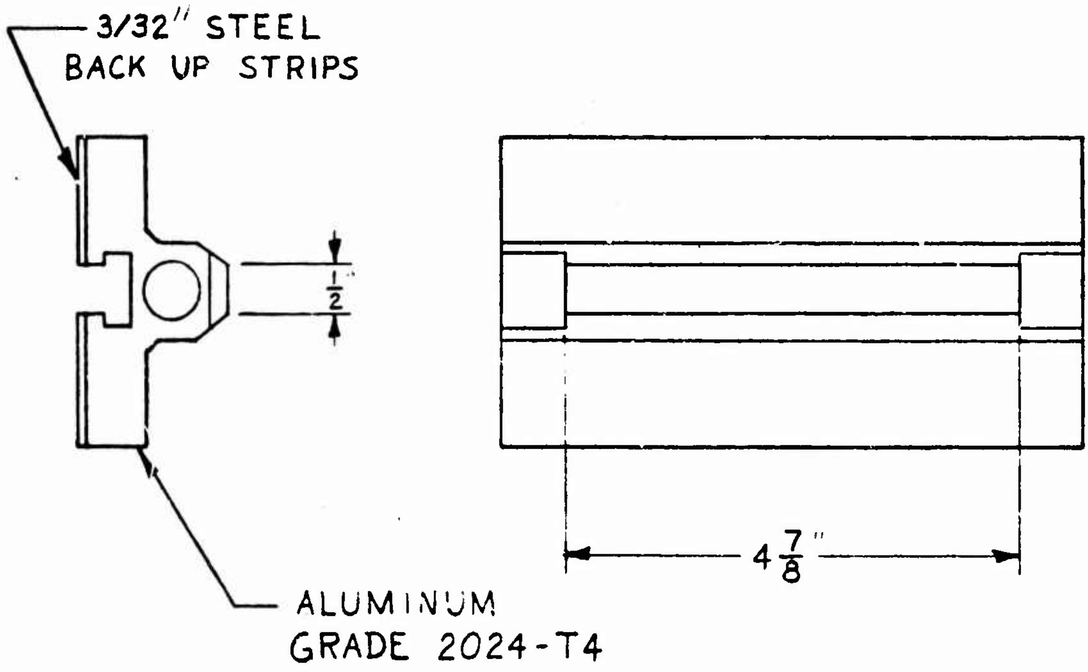


FIGURE DD 8. BOTTOM HEAT SEALING BAR

PYROMETER USED — Service Tectonics Model MP

TEMP. CONTROLLER — API Model 227

BAR No. See Figure DD-8.

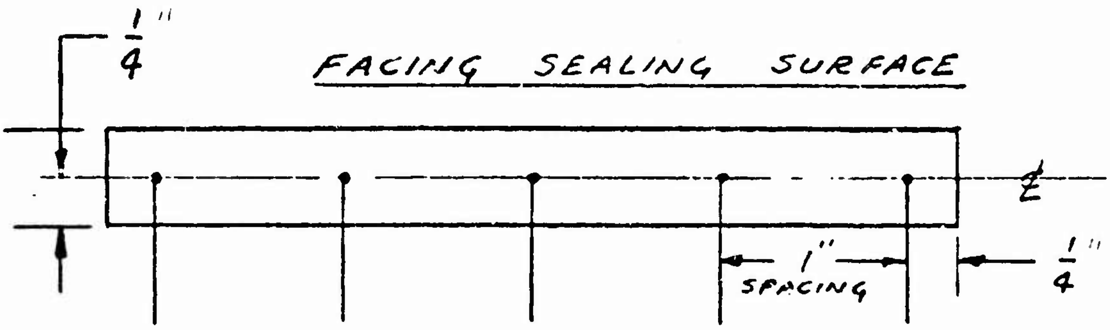
MATERIAL Aluminum 2024-T4

TEMP. SETTING 425 °F

REMARKS

MAX. VARIATION °F

30 Min. 10°
60 Min. 5°
90 Min. 10°



30 Min.	435 °F	435 °F	430 °F	425 °F	425 °F
60 Min.	435	435	430	430	430
90 Min.	435	435	430	425	425

Level Time - 15 Min.

Heater - 1000 Watt Watlow
1/4" Collar Each End

Rear Bar

Figure DD 9. TEMPERATURE MAPPING -- BOTTOM SEAL BAR.

3. Temperature Control Systems

Three different types of temperature control systems were evaluated during this study. These were:

a) Variable Voltage Transformer Controller
b) On-Off Time Proportioning Temperature Controller
c) Voltage Proportioning Temperature Controller

The voltage proportioning temperature controller, Model 227 manufactured by API, produced the most reliable temperature control of those tested. A voltage time delay control system must be used in conjunction with this temperature controller to achieve temperature variations of not more than ± 10°F. from run temperature set point during startup and run conditions.

A significant temperature drop (greater than – 10°F.) occurred on each test startup regardless of the combination of temperature controller, cartridge heater, seal bar, or thermocouple probe location used. This was due to the inability of the temperature control system to instantaneously sense and recover the heat dissipated during machine startup.

The following sequence of voltage control to the cartridge heating elements was manually simulated and proven successful. We recommend that the following automatic control circuit be included in the production phase machine.

Upon depression of the machine start switch at the beginning of a normal packaging run, an electrical time delay relay is energized switching full line voltage to the cartridge heating elements by by-passing the temperature controller. This is equivalent to anticipating and providing the initial heat requirement for startup conditions. The machine is prevented from starting for an adjustable time period of from 10 to 15 seconds. At the end of this time delay, the relay is de-energized and control is reverted to the temperature controllers. The machine will then automatically start producing pouches in a normal manner.

Upon each machine stoppage, a temperature overshoot (greater than + 10°F.) will be experienced for a period of approximately two minutes during which time the temperature will return to set point. We recommend that an additional time delay relay circuit be installed in the production phase to prevent recycling of the machine before set point temperature is attained.

An improvement over our standard thermocouple probe location was established during this study. This improvement involves positioning the probe closer to the seal bar sealing surface to sense temperature changes more rapidly. We recommend this improved probe location for the production phase.

4. Heat Sealing Methods

Two heat sealing methods for each of two sets of sealing bars were investigated during this study. Each method consisted of two sets of sealing bars, one bottom and one side seal set, positioned to permit the packaging material to be advanced between the seal bars.

The two methods are:

a) Both heat seal bars heated to the same temperature.

b) One bar heated, the opposite bar either unheated or only partially heated.

Method (b) with the opposite bar partially heated resulted in seals more closely conforming to all of the heat seal specifications. We recommend this system for the production phase of this program.

Figures DD 10 and DD 11, represent the machine cross section for method (a) side and bottom seals, respectively, and DD 12 and DD 13 for (b) side and bottom seals, respectively.

The teflon coated glass cloth, silicone rubber, and temperature setting recommendations are included in Table DD II.

Testing indicates that the teflon coated glass cloth can stick to the packaging material after repeated heat sealing due to the high sealing temperature and pressure required to seal this material. The result is wrinkling of the pouch seal area. To overcome this, we recommend that a teflon cloth indexing device for each seal station be developed to reposition the teflon cloth, in possibly an endless belt form, after each few heat seals are produced.

A roll of packaging material weighs in excess of 100 lbs. We recommend a powered web feed for the production phase to improve the operation of the packaging machine by more uniformly controlling the intermittent advance of material.

5. Heat Sealing Pressure

Our testing has shown that approximately 185 lbs per square inch sealing pressure (pressure exerted by the seal bar sealing surface against the packaging material and the silicone rubber) is required to produce acceptable seals. Adequate sealing pressure is achieved by properly adjusting the spring pressure assemblies provided on both the side and bottom seal units. The recommended springs for the production phase are included in Table DD II.

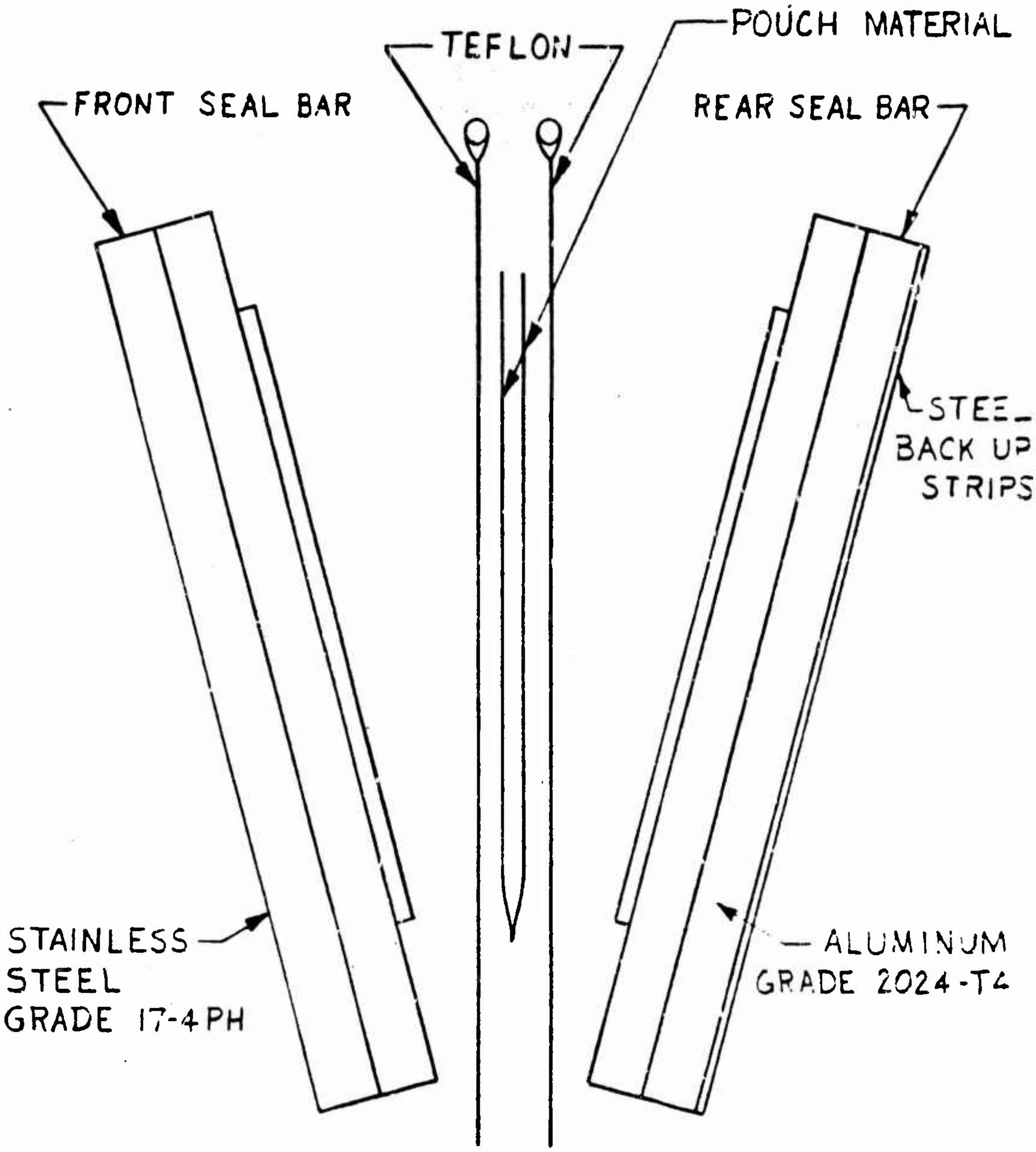


FIGURE DD 10 SIDE SEAL BARS — BOTH HEATED

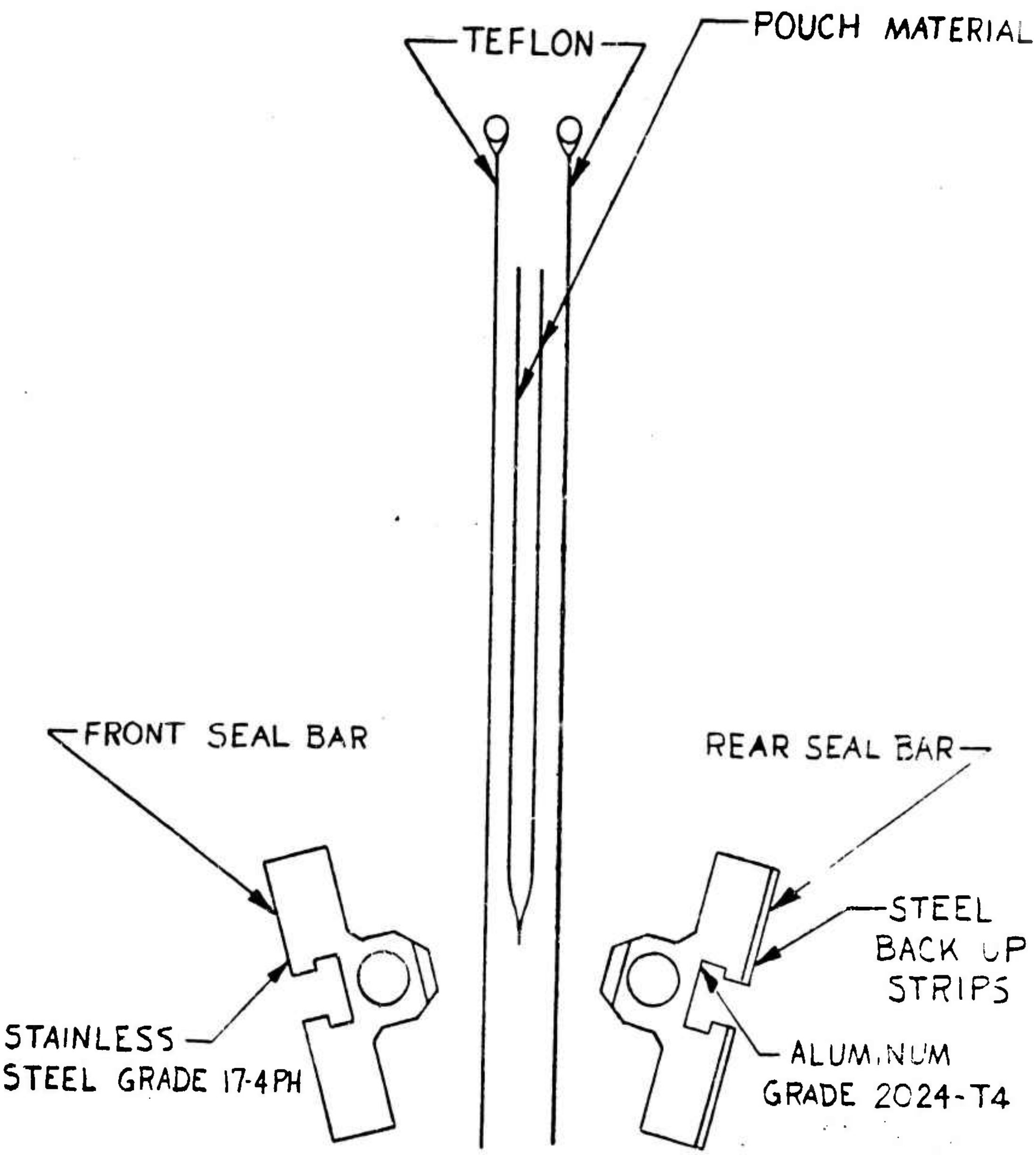


FIGURE DD 11. BOTTOM SEAL BARS — BOTH HEATED

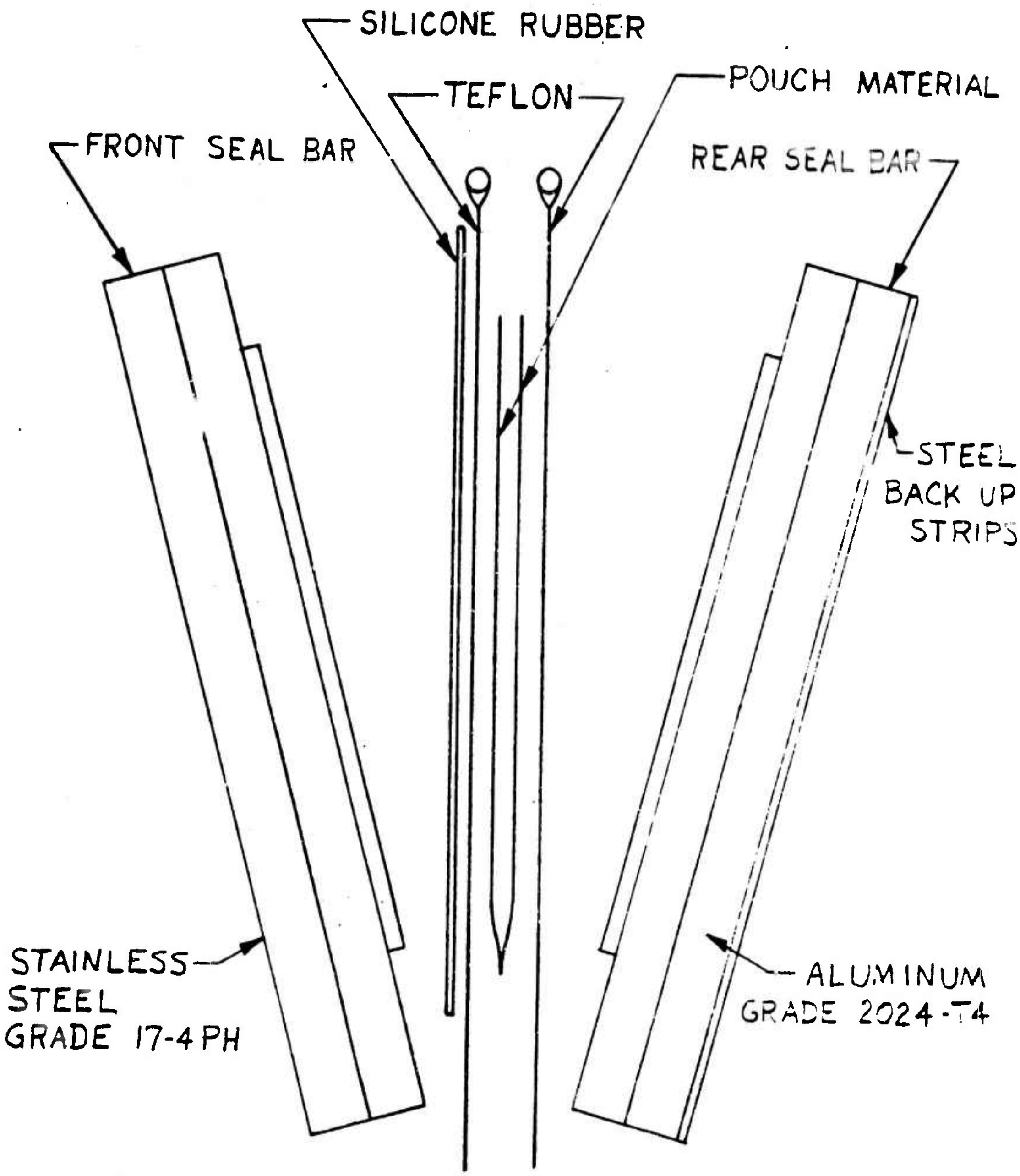


FIGURE DD 12 SIDE SEAL BARS – REAR HEATED

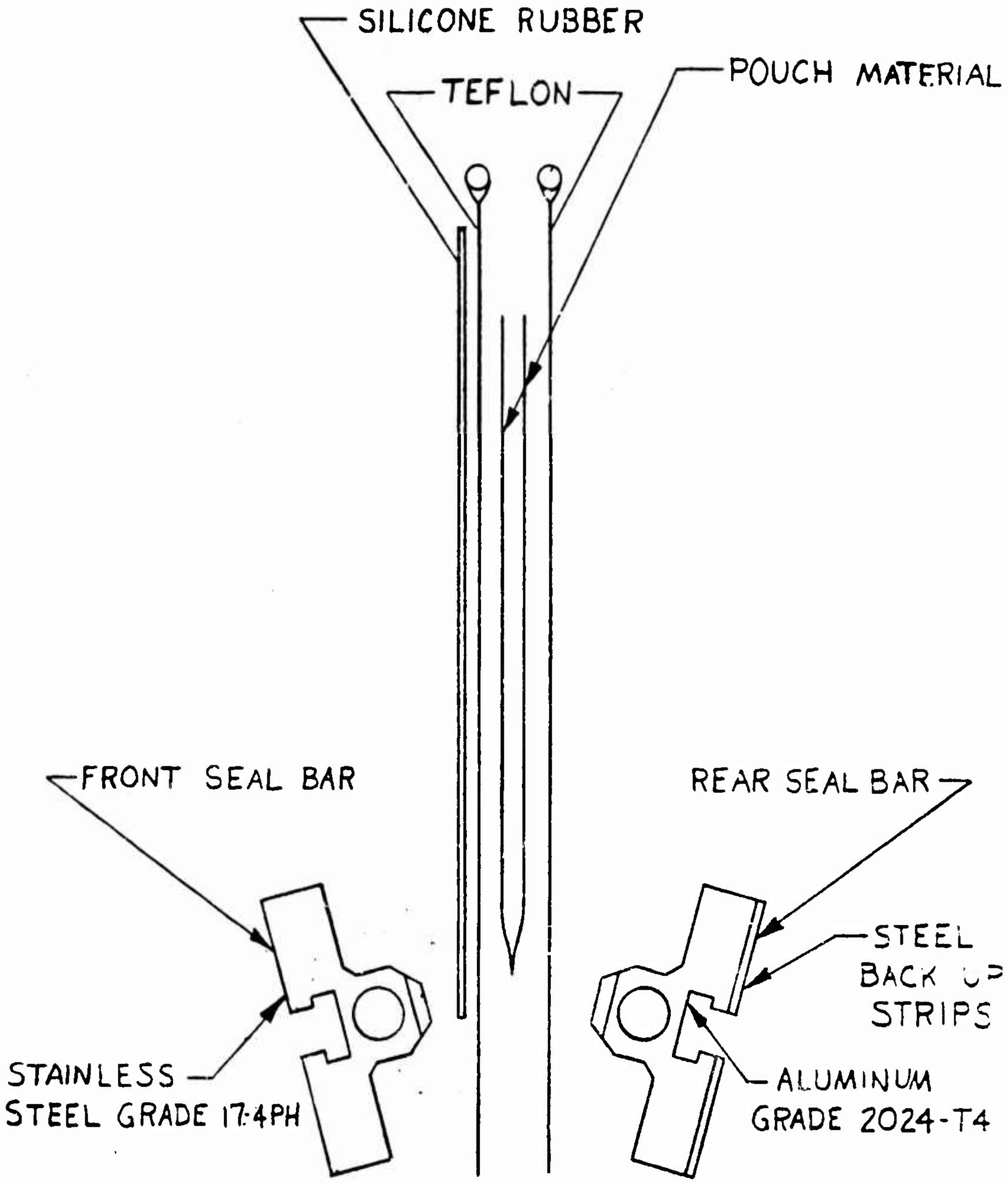


FIGURE DD 13. BOTTOM SEAL BARS — REAR HEATED

6. Pouch Easy Opening Notch Cut-Out

We have modified one of our standard pouch notching assemblies to produce the required notch cutout for this program.

7. Heat Seal Cooling Bars

We have adapted one of our standard sets of cooling bars for cooling both the pouch bottom and side seals. Each set of cooling bars consists of two separate and opposing bars which contact each seal on both sides of the material at the machine station immediately following each heat seal.

For the purposes of our Phase I testing, we parasitically mounted the cooling bars from the side seal rocker arm assembly. We recommend an individual rocker arm assembly for each set of cooling bars in the production phase of this program. The parasitic mounting is shown in Figures DD 14 and DD 15.

Our tests indicate that refrigerated cooling bars are required. This was accomplished by installing a refrigeration unit circulating anti-freeze through a cooling bar system. We recommend a refrigerated system for the production phase.

8. Photo Registration

We adapted one of our standard photo electric scanner assemblies to detect the pouch easy opening notch cutout. Using the notch as a registration point, we have successfully produced pouches meeting the dimensional specifications. We recommend that a printed photo registration reference mark be included in the packaging materials specification to further insure dimensional stability.

9. Evaluating Finished Pouches (see Figure C 5).

Pouches have been successfully produced using the sequence of operations shown in Figure DD–16 and tested in the following manner.

One-inch-wide samples, cut from two positions in each of the three pouch seals, were evaluated for tensile seal strength. The seal strength specification is 16 to 18 pounds per inch as a target value with a minimum of 12 pounds per inch acceptable for one individual sample of the six samples taken from a single pouch.

Our seal strengths were equal to or exceeded the target specification.

Pouches were also evaluated by internally pressurizing the pouch to 45 psig in 30 seconds and holding at 45 psig for an additional 30 seconds. Our pouch samples have successfully met this specification.

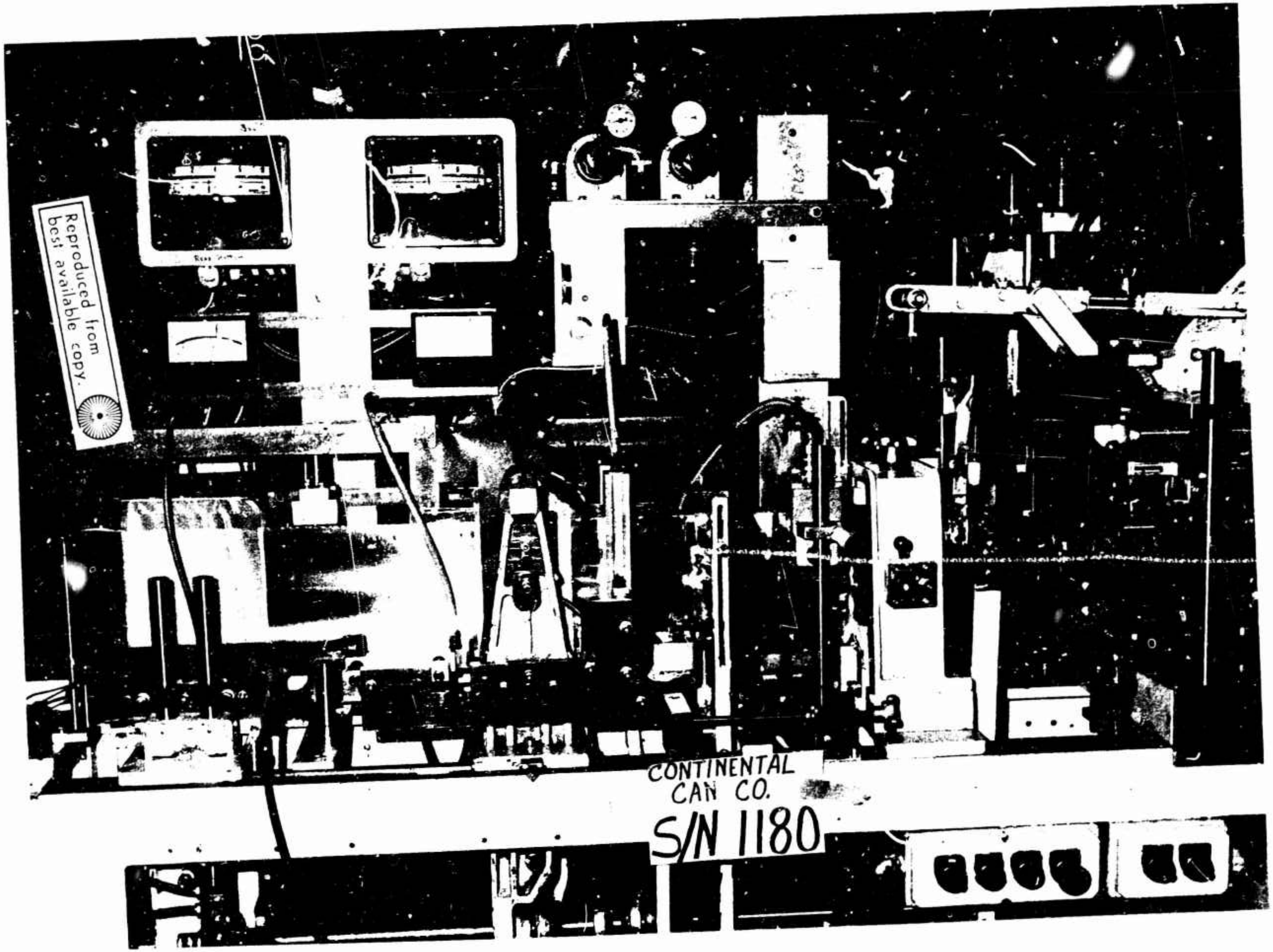


FIGURE DD-14. BENCH MODEL PACKAGING MACHINE SHOWING PARASITICALLY MOUNTED COOLING BARS.

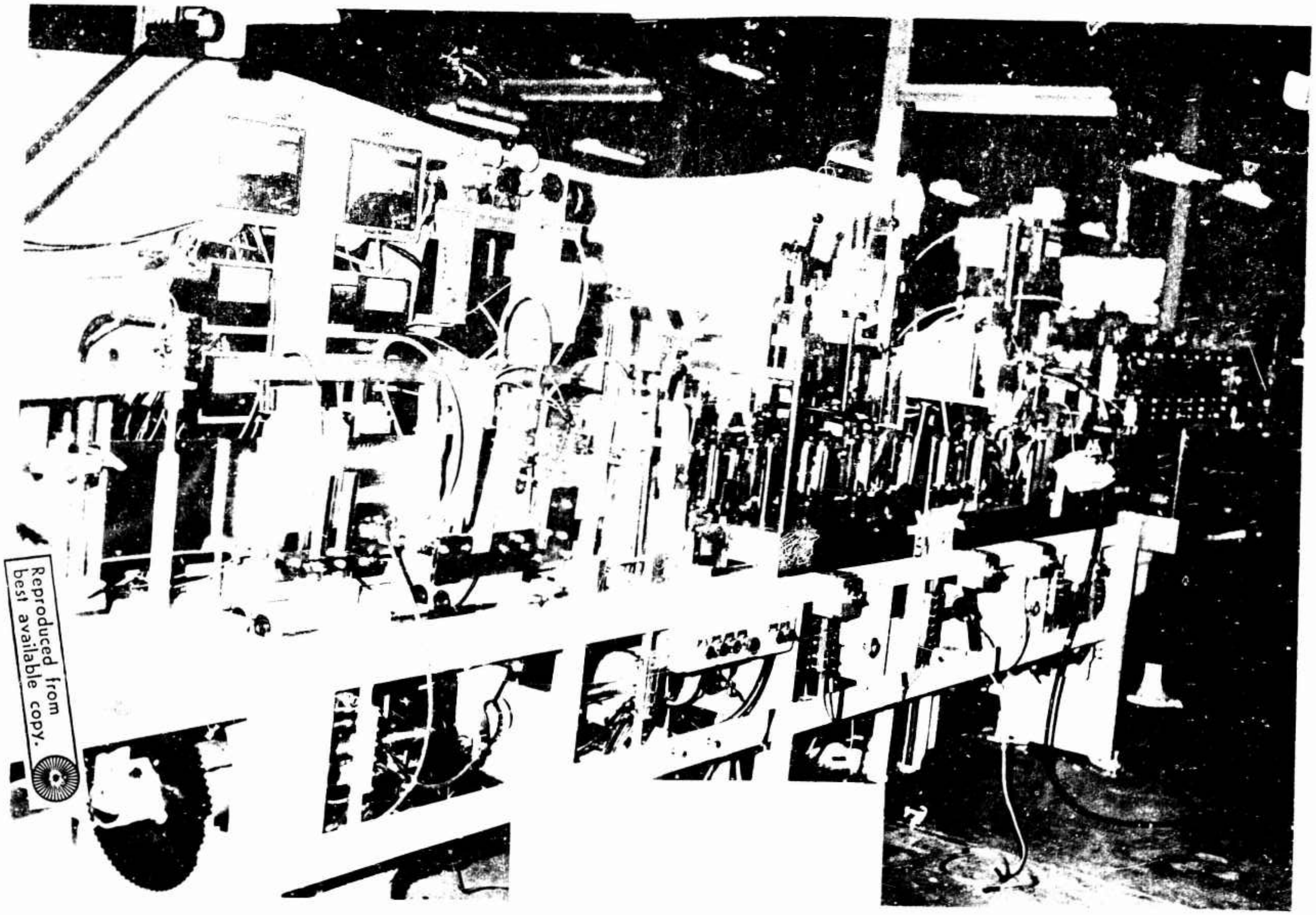


FIGURE DD 15. BENCH MODEL PACKAGING MACHINE SHOWING PARASITICALLY MOUNTED COOLING BARS.

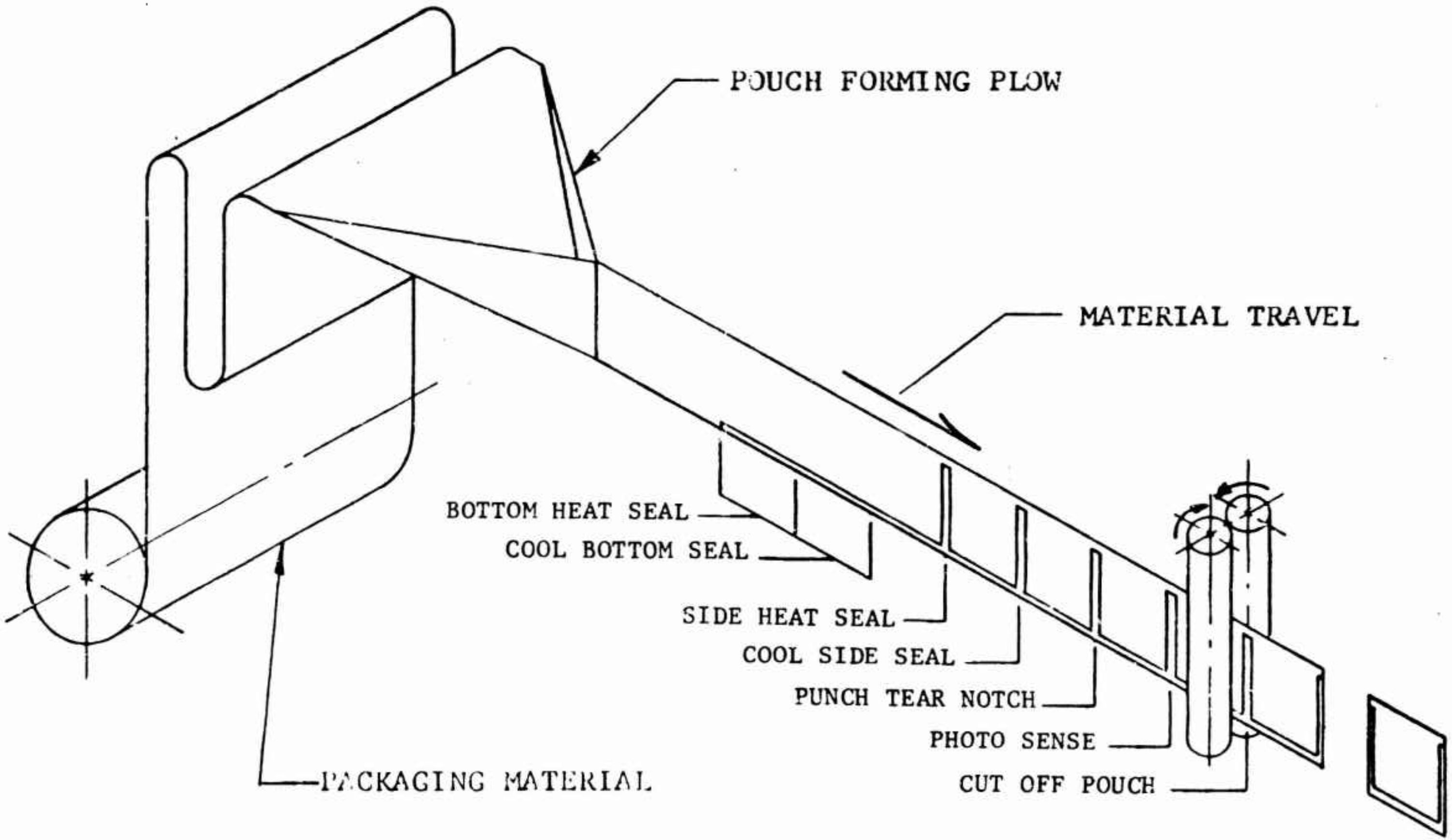


FIGURE DD 16. SCHEMATIC DRAWING OF POUCH MAKING.

9. Evaluating Finished Pouches (Cont'd)

The heat seal specification, established and provided by Task C, stipulates that the heat sealing bars should retain their ± 10°F. maximum temperature variation throughout a temperature range of 250° to 600°F.

We believe this 250° to 600°F. specification range is unnecessary and recommend that it be revised to machine run temperature set point ± 25°F. for each bar in the system.

Extensive tests indicate that temperatures beyond ± 25°F. from run temperature set point produces objectionable heat seals. Our recommended heat seal bars have been tested in the set point temperature ± 25°F. range and were successful in meeting the ± 10°F. maximum temperature variation specification. The set point temperature for each bar is listed in Table DD II.

Tests have shown that the packaging material positioned between the side and bottom heat seal bars during machine standby conditions is damaged by the heat radiating from the seal bars. To eliminate this problem, we recommend a redesign of our seal actuator assemblies in the next phase to incorporate heat shield protection between each seal bar and the packaging material.

We also recommend automatic web edge guiding to automatically and accurately control the top lip of the pouch.

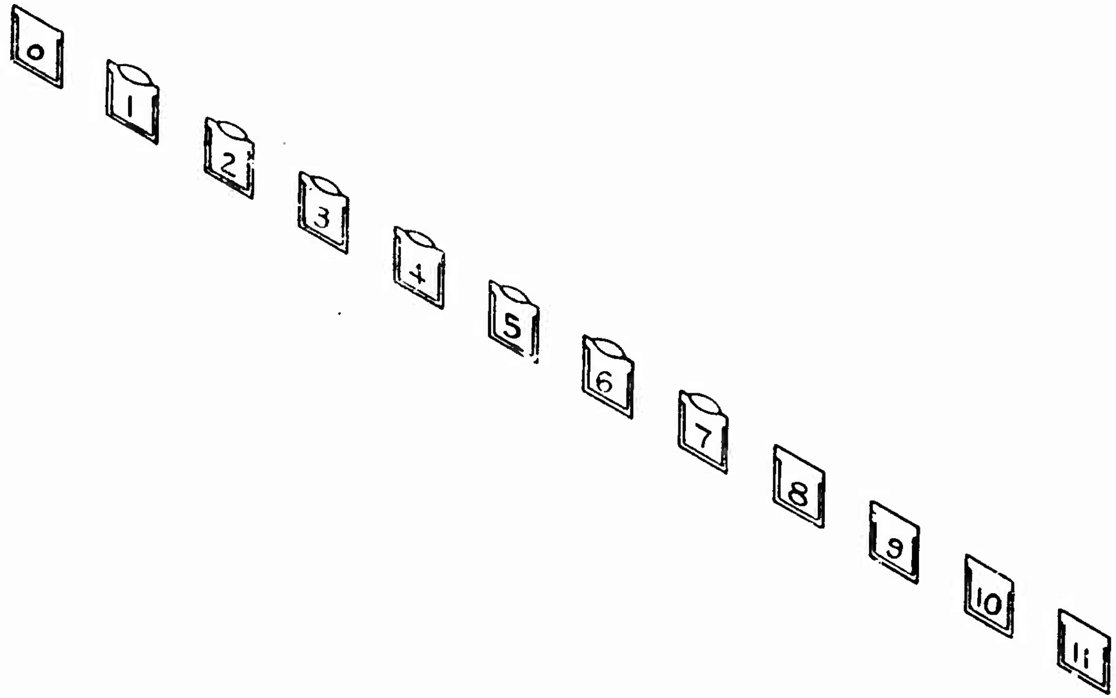
It has been necessary to increase the distance between the top of the pouch and the top of each side seal from 1/4" + 1/16" -0" to 5/16" + 1/16"-0" to insure that the packaging material can be guided through the pouch making and pouch opening sections of the packaging machine. This change is shown in Figure C 5 and is recommended for the production phase.

The easy opening notch cutout is presently positioned 1" down from the top of the pouch. The notch location interferes with the machine bag clamp position and objectionable damage is occurring on each pouch. We recommend that the notch be repositioned at 7/8" down from the top of the pouch to eliminate this problem.

Product Filling

Each finished pouch is transferred from the pouch making portion of the packaging machine to the filling conveyor or packaging section of the machine for subsequent pouch opening, filling, and closing operations as shown in Figures DD 17, 18, and 19.

Each pouch is gripped by a leading and trailing bag clamp to permit controlled opening, as shown in Figure DD 19, and conveying through the machine.



0 POUCH PICKUP STATION
1 AIR JET OPENING STATION
2 POUCH FORMING STATION
3- 7 PRODUCT FILLING STATIONS
8 TOP PRE-SEAL (IF REQUIRED) STATION
9-10 OPEN
11 POUCH REMOVAL STATION

FIGURE DD 17. SCHEMATIC DRAWING OF POUCH OPENING, FILLING AND CLOSING.

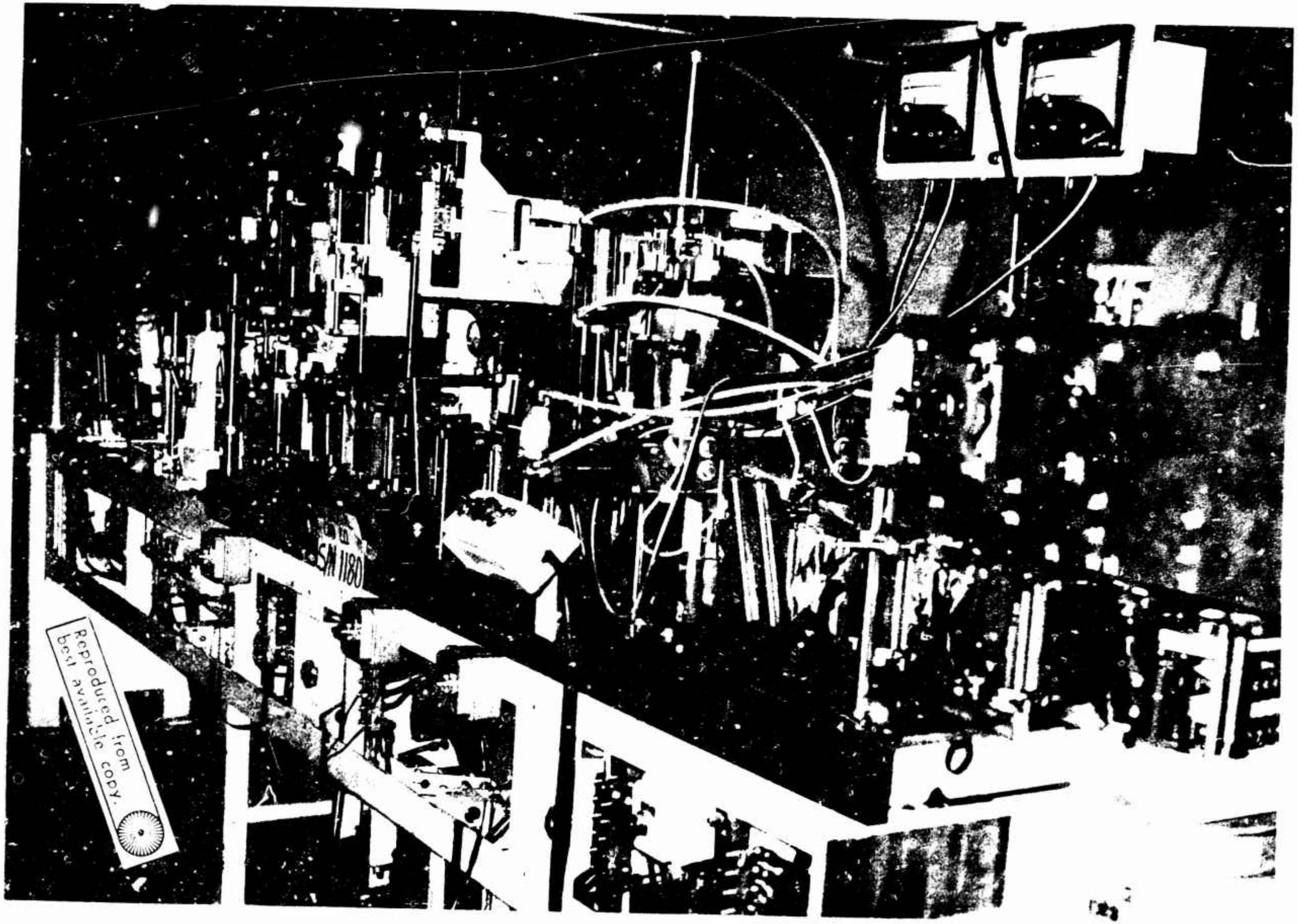


FIGURE DD 18. BENCH MODEL PACKAGING MACHINE, POUCH OPENING AND FILLING SECTION.

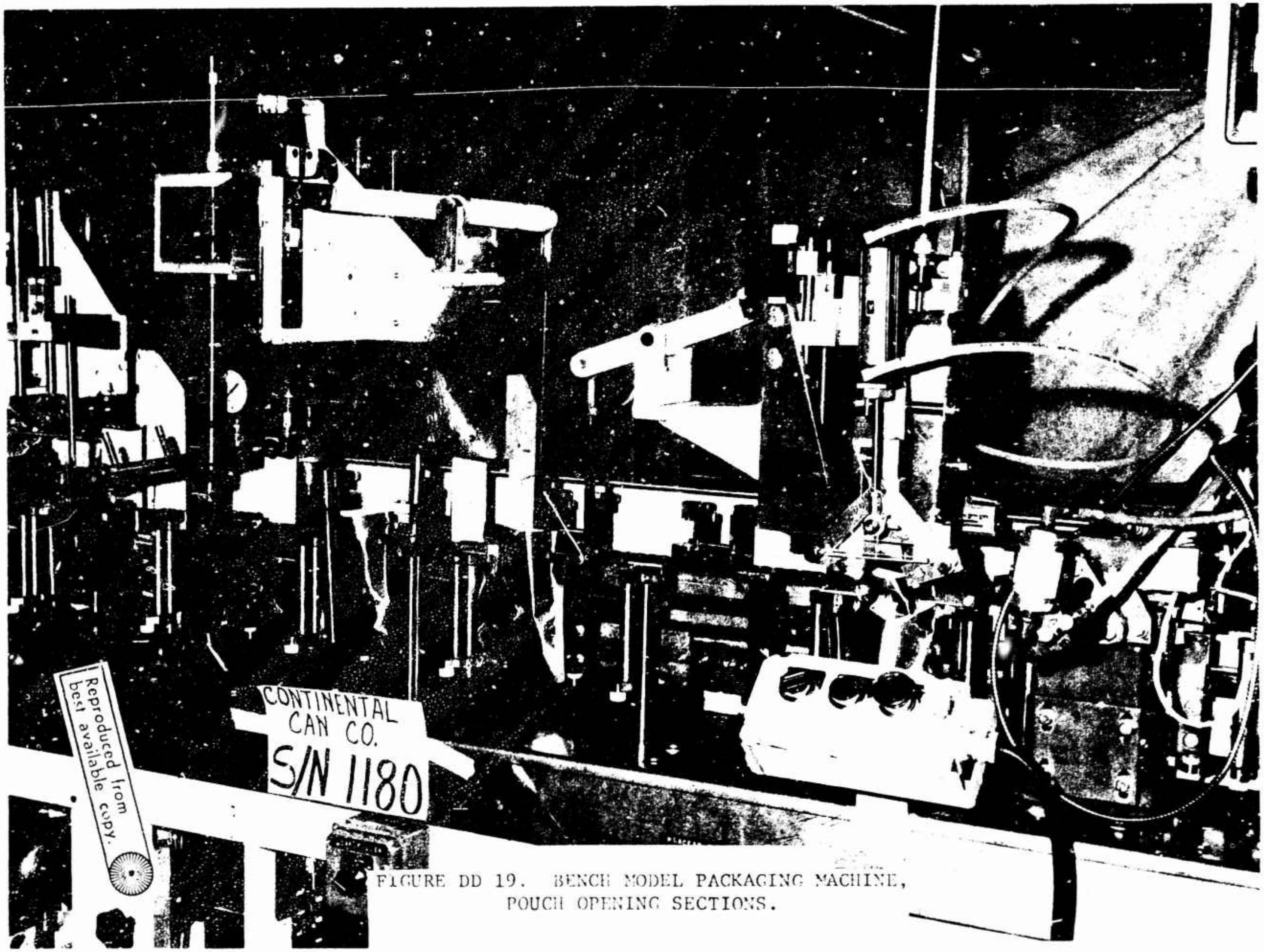


FIGURE DD 19. BENCH MODEL PACKAGING MACHINE, POUCH OPENING SECTIONS.

As a pouch is transported into the 11-station packaging portion of the machine, it first enters the air jet station which blows open the entire pouch slightly. In the second station, an air/mechanical pouch former is positioned into the pouch to form an oval pouch opening for product filling as shown in Figure DD 20. Vacuum cup pouch opening provisions, to assist the mechanical pouch openers, will be used in the next phase if necessary. The next five machine stations are available for product filling. The eighth station is available for presealing the top of the pouch if required. (This study was omitted in Phase I by Task D.) The next two stations are open stations. The last station is the pouch pick-off station for removal of the pouch from the packaging machine for subsequent operations performed in Task D of this program.

1. Determine Pumpable Product Filling Method

The eleven pumpable products studied were:

a) Barbecue Sauce
b) Beans in Tomato Sauce
c) Beef Stew
d) Bread
e) Chicken Ala King
f) Chocolate Nut Cake
g) Orange Nut Cake
h) Fruit Cake
i) Pickle Flavored Sauce in Ground Beef
j) Pineapple in Syrup
k) Pound Cake

Table DD VI lists the types of filling methods tested for each product. Table DD III lists the recommended filling and dispensing nozzle combination for each product.

Two different fillers are required and recommended for pumpable products. These are:

a) Bock Piston (Modified) Filler
b) CP St. Regis Stuffer Filler

Each of the filling devices was evaluated for filling speed, accuracy of fill, and absence of damage to the product. Each filler was successful in meeting these requirements.

Figures DD 21 and 22 show the Bock and CP St. Regis Fillers. Figures DD 23, 24 and 25 show the Bartelt Model D, Speedy, Bartelt volumetric, Bartelt vibratory, Exact Weight net-weight scale and Bursa-Fill fillers evaluated in this study.

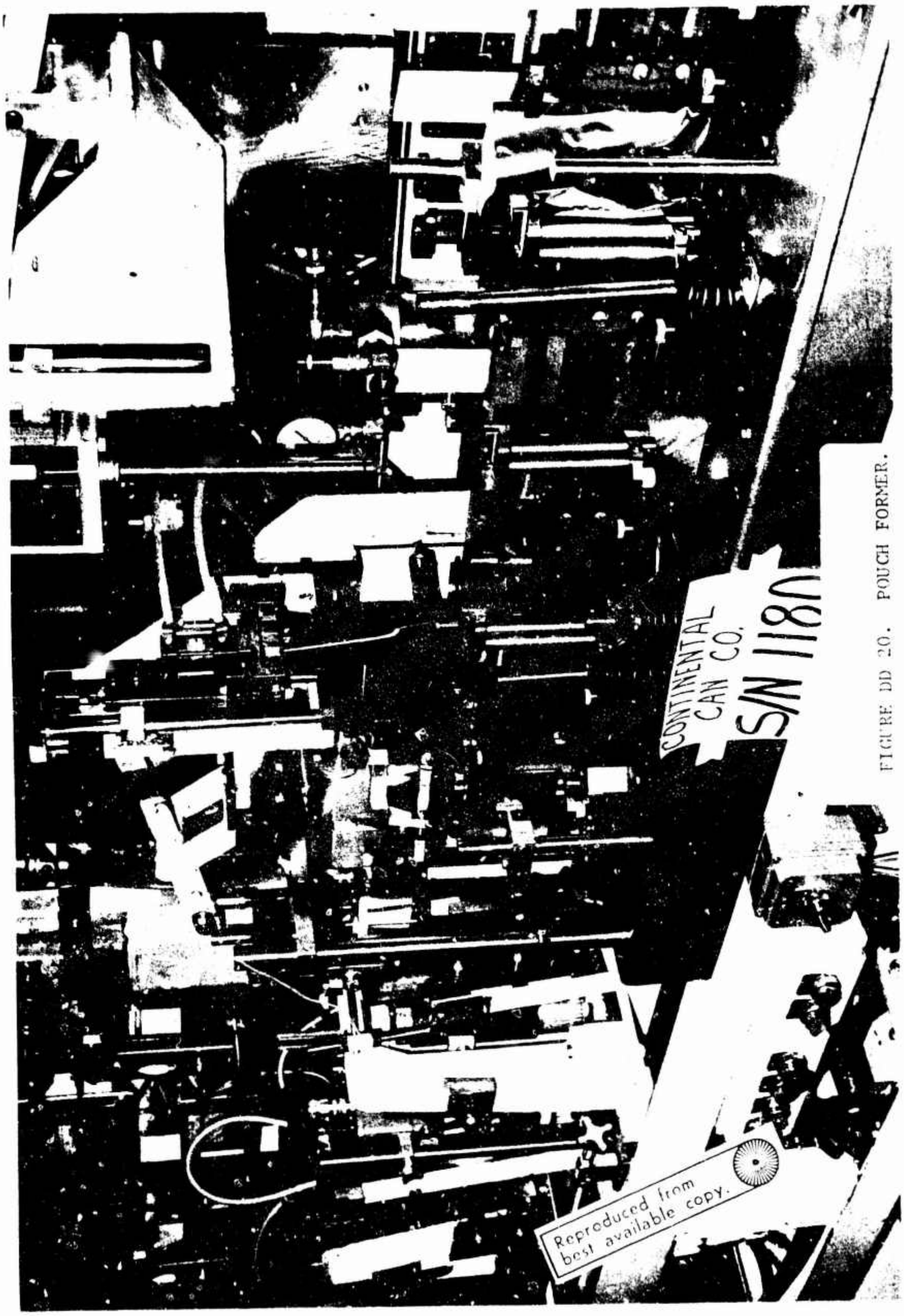


FIGURE DD 20. POUCH FORMER.

TABLE DD VI

PUMPABLE PRODUCTS

PRODUCT	FILLING METHOD TESTED
Beans	Volumetric Cup
	Net Weight
Tomato Sauce	Bartelt Model D/Moyno Pump
	National Pump
	Bursa-Fill
	Bock Piston (Modified)
Beans and Tomato Sauce	Bursa-Fill
	Bock Piston (Modified)
Meat–Beef Stew	Volumetric Cup
Carrots–Beef Stew	Volumetric Cup
Lima Beans–Beef Stew	Volumetric Cup
Potatoes–Beef Stew	Volumetric Cup
Mixed Vegetables–Beef Stew	Volumetric Cup
	Net Weight
	Vibrator Filler
Mixed Vegetables and Gravy–Beef Stew	Bursa-Fill
	Bock Piston (Modified)
	CP Stuffer
Gravy–Beef Stew	National Pump
	Bartelt Model D/Moyno Pump
	Bock Piston (Modified)
Beef Stew	Bock Piston (Modified)
	Bursa-Fill
	CP Stuffer
Chicken Ala King	Bursa-Fill
	Bock Piston (Modified)
Chocolate Nut Cake	Bock Piston (Modified)
	CP Stuffer
	CP Stuffer/Bursa-Fill
	CP Stuffer/Bock Piston (Modified)
Fruit Cake	CP Stuffer
Orange Nut Cake	CP Stuffer

TABLE DD VI (Cont'd)

PUMPABLE PRODUCTS

PRODUCT	FILLING METHOD TESTED
Ground Beef With Pickle Flavored Sauce	Bartelt Model D/Moyno Pump
	Bock Piston (Modified)
	Bursa-Fill
	Bartelt Model D
Crushed Pineapple	Bursa-Fill
	Bock Piston (Modified)
	CP Stuffer/Bursa-Fill
Pineapple Syrup	Bock Piston (Modified)
	Bartelt Model D/Moyno Pump
	National Pump
Pineapple in Syrup	Bursa-Fill
	Bock Piston (Modified)
Pound Cake	Bartelt Model D
	Bursa-Fill
	Bock Piston (Modified)
	CP Stuffer
Barbecue Sauce	National Pump
	Bock Piston (Modified)
Bread	Bartelt Model D/Sliding Tube
	CP Stuffer

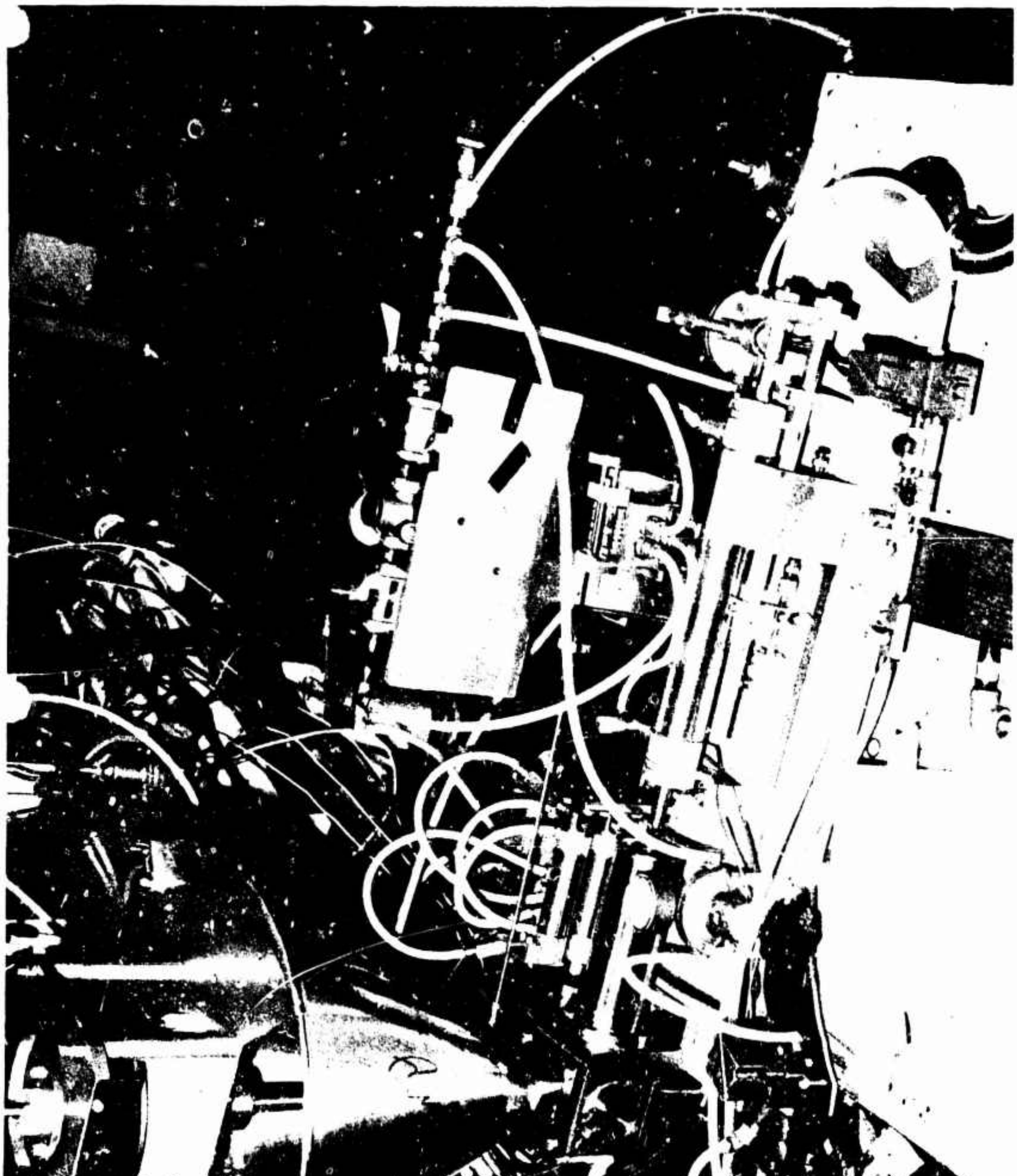


FIGURE DD 21. BOCK PISTON FILLER.

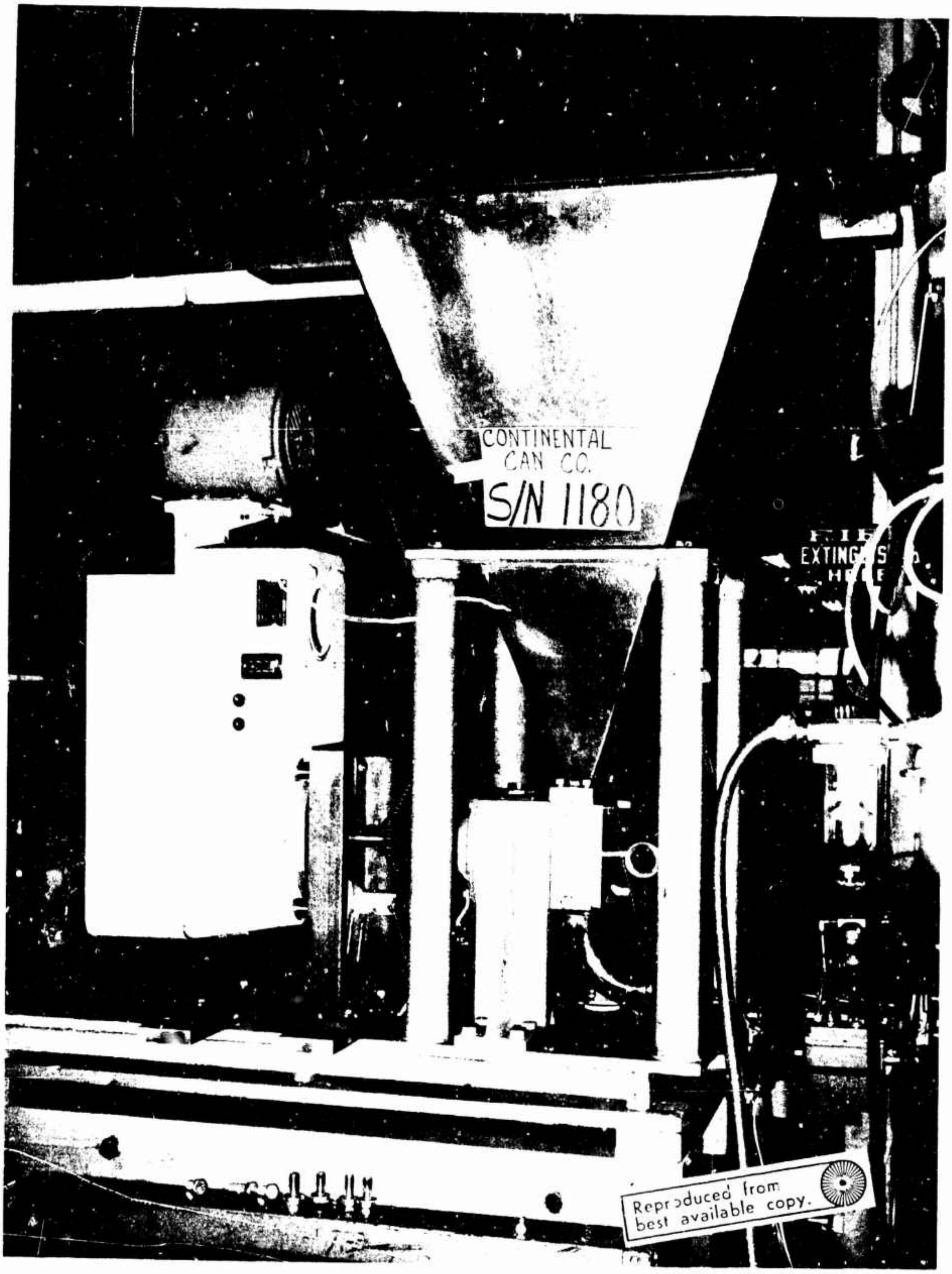


FIGURE DD 22. CP ST. REGIS STUFFER FILLER

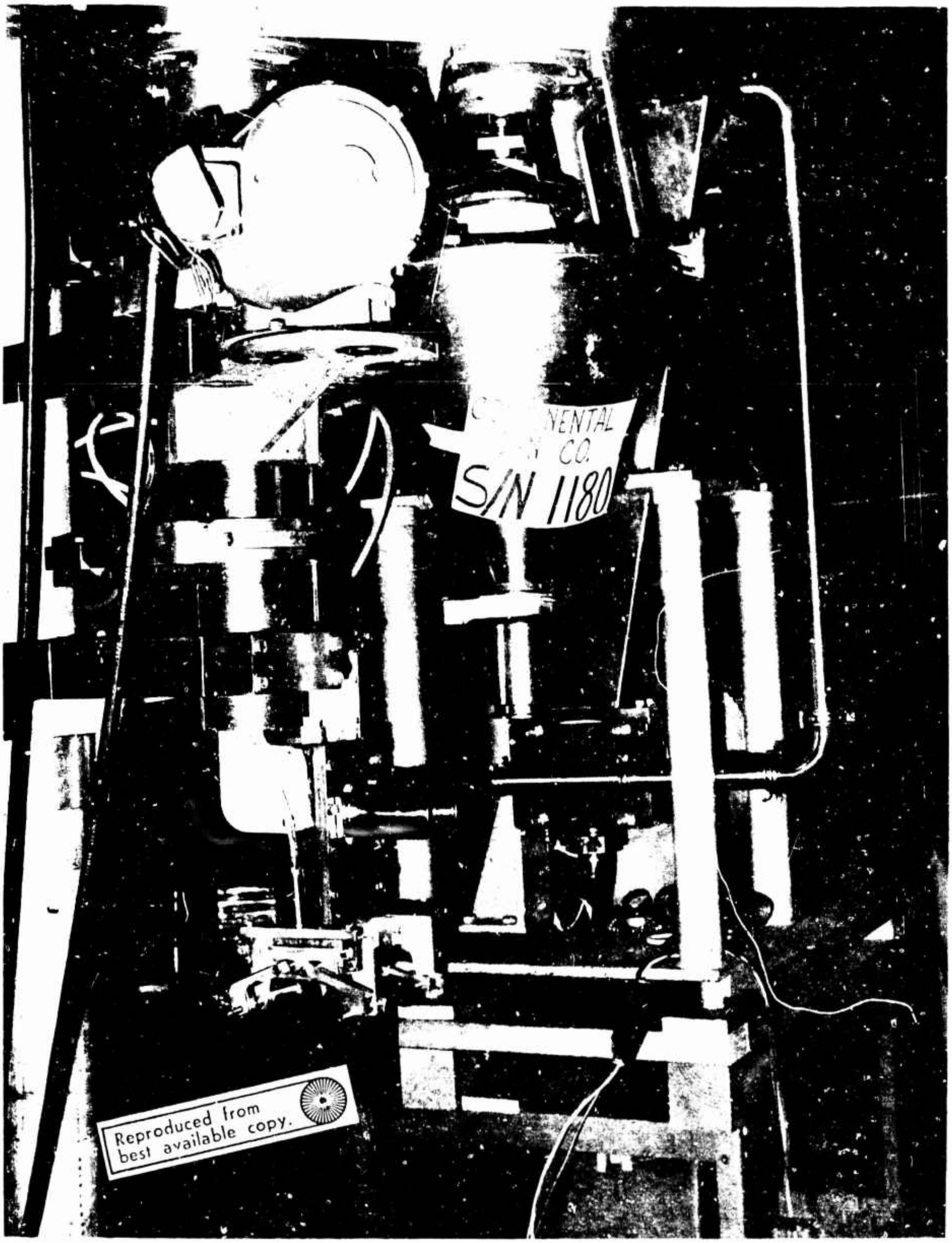


FIGURE 23. BARTELT MODEL D FILLER AND SLIDING TUBE NOZZLE.

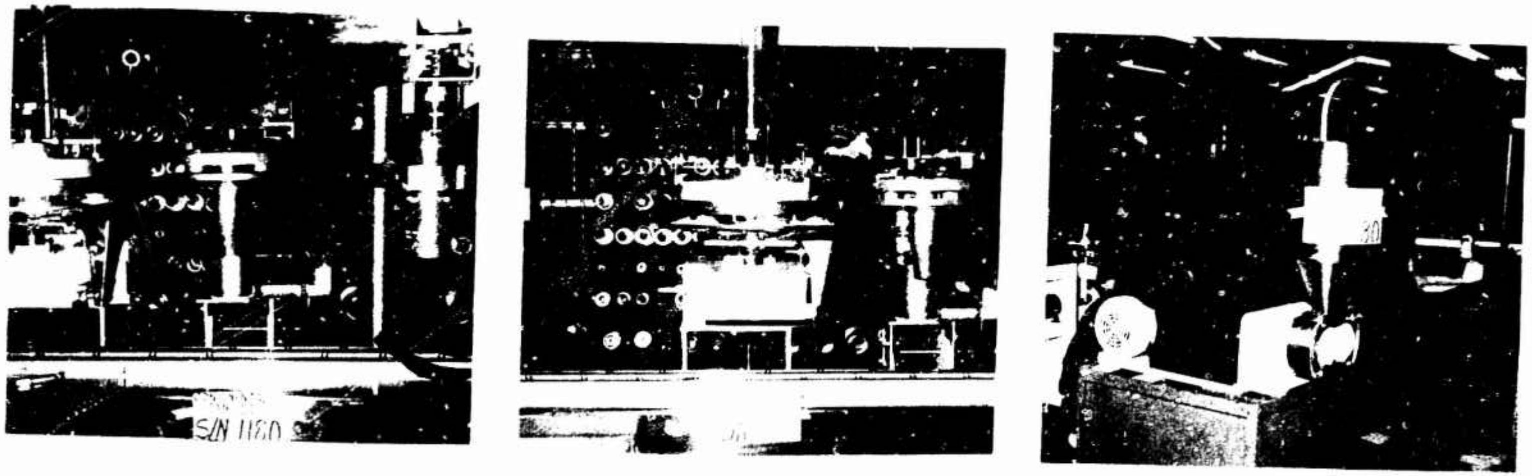


Figure DD 24. SPEEDY FILLER (left), BARTELT VOLUMETRIC FILLER (center), and BURSA-FILL FILLER (right).

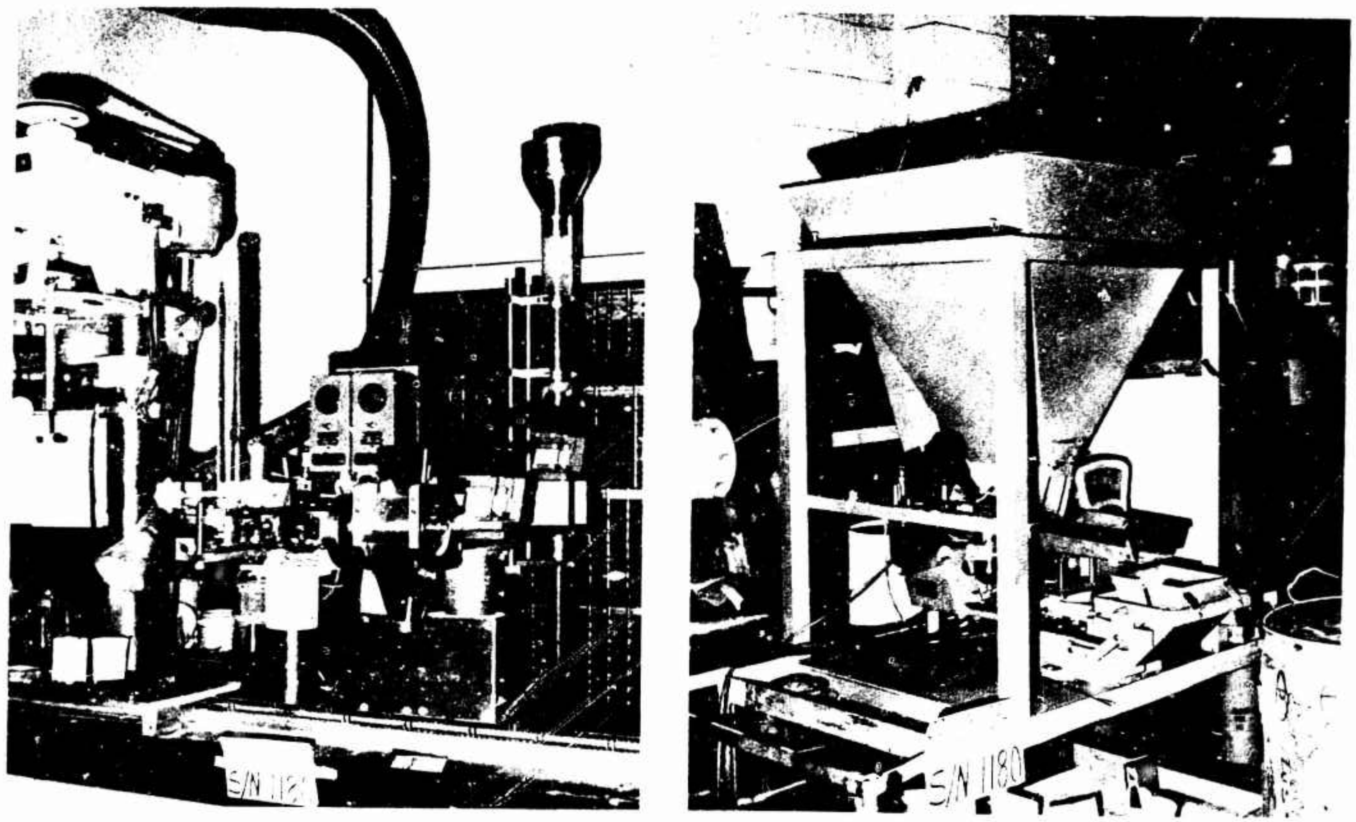


Figure DD 25. BARTELT VIBRATORY FILLER (left) and EXACT WEIGHT, NET WEIGHT FILLER (right).

Three different dispensing nozzles are required and recommended for pumpable products. These are:

a) 5/8"-Diameter Plug Nozzle
b) 1"-Diameter Plunger Nozzle
c) Rotary Valve Nozzle

Each of the dispensing nozzles was evaluated for filling speed, accuracy of fill, absence of damage to the product, and elimination of product drip. Each nozzle was successful in meeting these requirements.

To aid in eliminating top seal area contamination on the pouch, each nozzle will be positioned in the pouch prior to dispensing and removed only after dispensing and applying either a vacuum suckback or air blowoff to the nozzle.

Figures DD 26, 27, and 28 show the 5/8" diameter plug, 1" diameter plunger, and rotary valve nozzles, respectively. Figures DD 23, 29, and 30 show six additional dispensing nozzle developments evaluated during this study.

Separate food component filling of beans in tomato sauce, beef stew, and pineapple in syrup were evaluated. It is recommended that beans in tomato sauce and pineapple in syrup be filled as a combination of components rather than singularly. It is furthermore recommended that beef stew vegetables and gravy be filled as a combination and the beef stew meat be filled separately.

2. Determine Extrudable Product Filling Method

The three extrudable products studied were:

a) Beef Loaf
b) Chicken Loaf
c) Ham and Chicken Loaf

Table DD VII lists the types of filling methods tested for each extrudable product. Table DD III lists the recommended filling and dispensing nozzle combinations for each product.

One filler is required and recommended for extrudable products. This is a Bartelt Model D filler. This filler was evaluated for filling speed, accuracy of fill, and no damage to the product. This filler was successful in meeting these requirements and is shown in Figure DD 23, page 150.

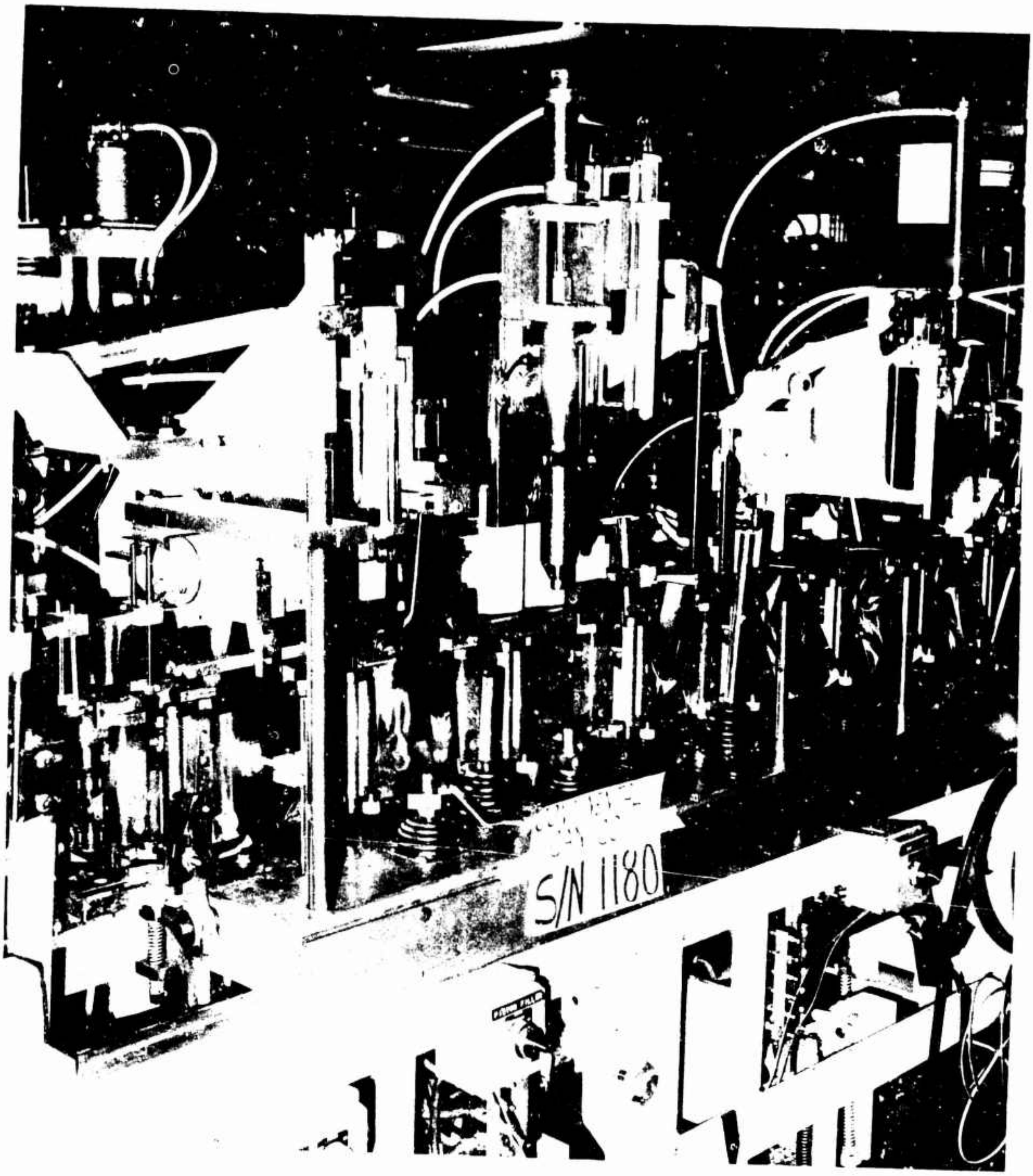


FIGURE DD 26. 5/8" DIAMETER PLUG NOZZLE.

FIGURE DD 27. 1" DIAMETER PLUNGER NOZZLE.

FIGURE DD 28. ROTARY VALVE NOZZLE.

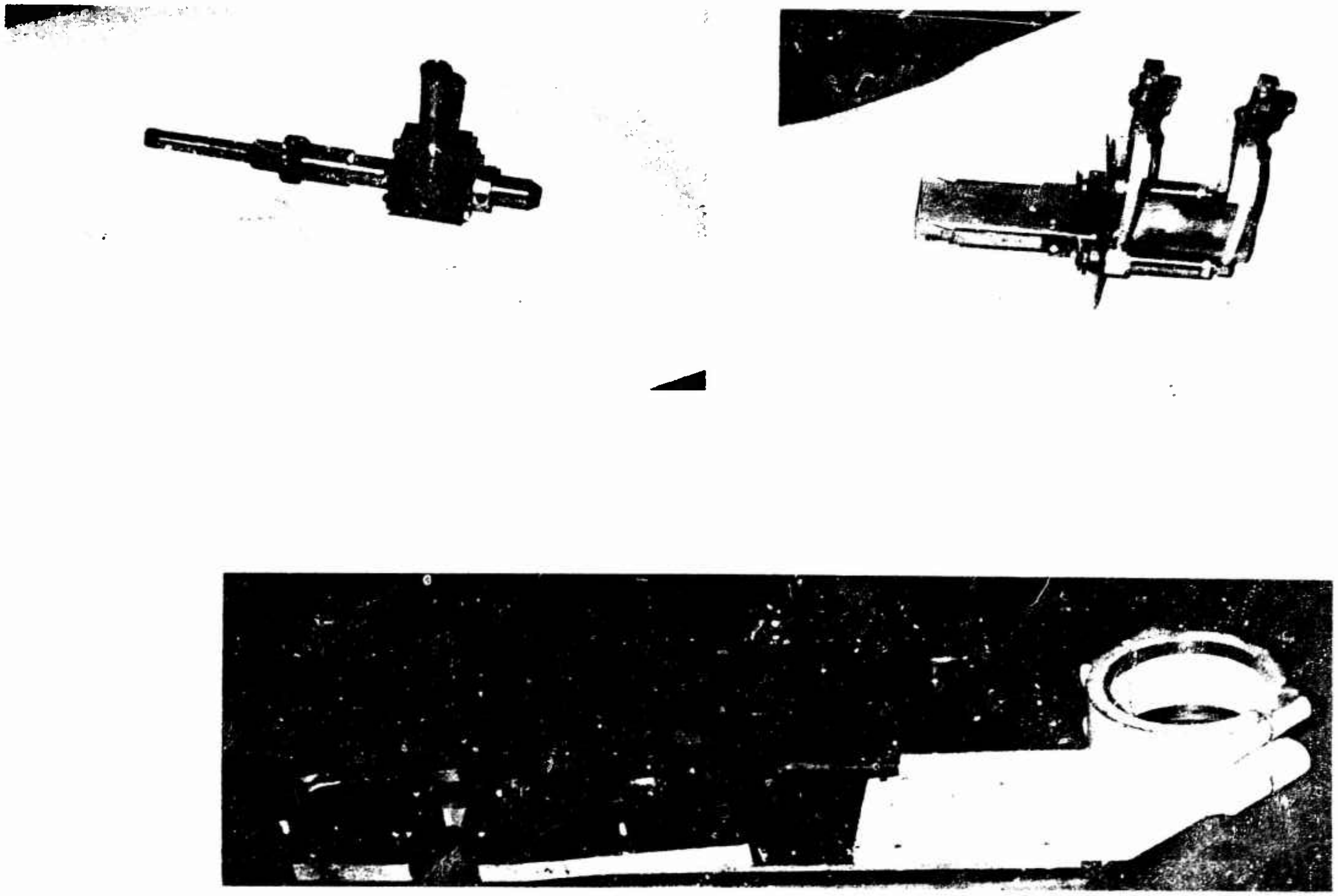


FIGURE DD 29. NOZZLES.

FIGURE DD 30. NOZZLES.

TABLE DD VII

EXTRUDABLE PRODUCTS

PRODUCT	FILLING METHODS TESTED
Beef Loaf	Bartelt Model D
	Bartelt Model D/Bursa-Fill
	Bartelt Model D/Sliding Tube
Chicken Loaf	Bartelt Model D
	Bartelt Model D/Sliding Tube
	CP Stuffer
Ham and Chicken Loaf	Bartelt Model D
	Bartelt Model D/Sliding Tube
	CP Stuffer

One dispensing nozzle is required and recommended for extrudable products. This is a sliding tube nozzle. The dispensing nozzle was evaluated for filling speed, accuracy of fill, no damage to the product, and elimination of product drip. This nozzle was successful in meeting these requirements.

To aid in eliminating top seal area contamination on the pouch, the nozzle is positioned in the pouch prior to dispensing and removed only after dispensing and applying an air blowoff to the nozzle.

Figure DD 23 shows the sliding tube nozzle.

3. Determine Placeable Product Filling Method

The four placeable products studied were:

a) Beef Slices
b) Beef Steaks
c) Frankfurters
d) Pork Sausages

We have developed two new placeable filling devices during our filling study of placeable products. Placeable filler, see Figure DD 31, was successful in dispensing the products and is recommended for this program. A dispensing nozzle is not required with this filling device. It is recommended that a rotary device be developed in the production phase to automatically load the placeable products into the placeable filler. The rotary device would be manually loaded.

To eliminate top seal area contamination on the pouch, the placeable filler is positioned in the pouch prior to dispensing product and removed only after filling has been completed. Two sheet metal shields also aid in protecting the top seal area of the pouch.

4. Summation

Table DD VIII lists the fill weight or count of all products for this program.

Table DD IX lists the filling speeds and temperatures of all products.

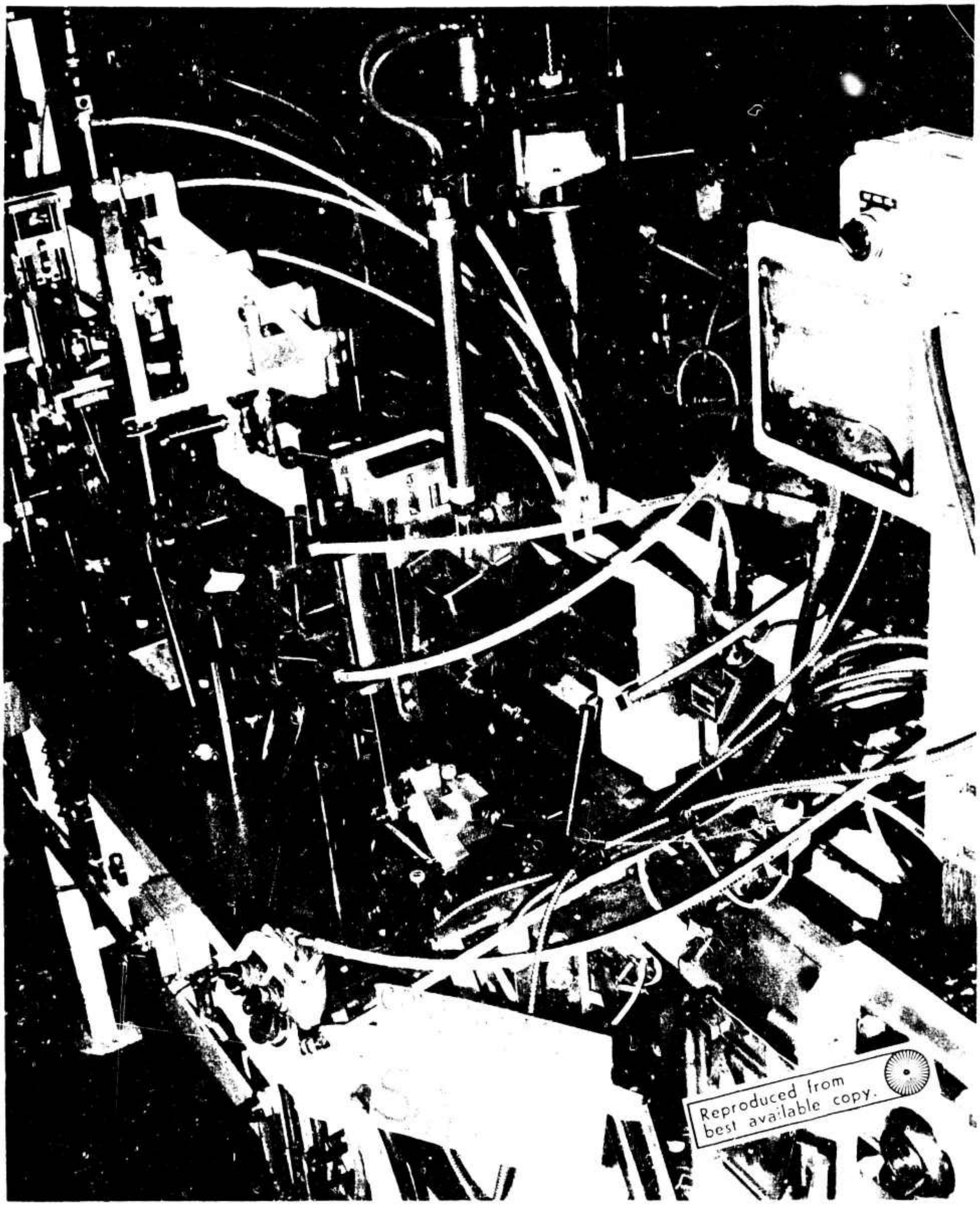


FIGURE DD 31. PLACEABLE FILLER.

TABLE DD VIII

PRODUCT FILL WEIGHT OR COUNT

PRODUCT	FILL WT., OZ., OR COUNT		
	Min.	Max.	Count
Beans in Tomato Sauce	4.50	5.25	
Beef Stew	4.50	5.50	
Chicken Ala King	4.50	5.50	
Chocolate Nut Cake	111 Gram	115 Gram	
Fruit Cake	118 Gram	122 Gram	
Orange Nut Cake	111 Gram	115 Gram	
Ground Beef With Pickle Flavored Sauce	4.50	5.50	
Pineapple in Syrup	4.25	5.00	
Pound Cake	98 Gram	102 Gram	
Beef Loaf	4.50	5.50	
Bread	69 Gram	73 Gram	
Chicken Loaf	4.50	5.50	
Ham & Chicken Loaf	4.50	5.50	
Beef Slices in Barbecue	4.50	5.50	2
Sauce	2.125	2.375	Sauce
Beef Steak	4.50	5.50	1
Frankfurters	4.50	5.50	4
Pork Sausages	4.00	5.50	4

TABLE DD IX

PRODUCT FILLING SPEED AND TEMPERATURE

PRODUCT	PKGS./MIN.		°F.
Beans in Tomato Sauce	30		70
Beef Stew	30		70
Chicken Ala King	30		70
Chocolate Nut Cake	30		70
Fruit Cake	30		70
Orange Nut Cake	30		70
Ground Beef With Pickle Flavored Sauce	30		70
Pineapple in Syrup	30		70
Pound Cake	30		70
Beef Loaf	30		70
Bread	30		70
Chicken Loaf	30		70
Ham & Chicken Loaf	30		70
Beef Slices in Barbecue Sauce	30	Slices	40
		Sauce	70
Beef Steak	30		40
Frankfurters	30		40
Pork Sausages	30		40

Task E Technical Feasibility of the Processing System

This task concerns establishing of the feasibility of the thermoprocessing system for flexible pouches and equipment necessary for implementing the process. This includes pouch carriers, retort racks, drying tunnel, and forming apparatus for overwraps. Prior art eliminates the need for demonstration of feasibility for the drying tunnel and overwrap forming.

The feasibility of using pouch carriers and retort racks in retorting has been demonstrated by trial and their compatibility with the packaging system by related prior art. These designs are recommended for the production system.

Pouch Carriers and Retort Racks

The pouch filled with product is shapeless, and after leaving the form/fill module cannot be handled satisfactorily. By inserting the pouch into a carrier (see Figure E-1), known can handling techniques can be used in transporting the pouch through the processing system, the vacuumizing, final seal, and thermoprocessing operations.

The pouch carrier, shown in detail in Figure E-2 and Figure E-3, has been designed as a multi-purpose unit. It is not only an integral part of the retort rack but is used for controlling and transporting the flexible pouch through the processing system.

The original concept was to fabricate the pouch carrier from stainless steel. In discussions with various fabricators, it was determined that this method would not be economical compared with a die casting of either zinc or aluminum, or an injection molded thermosetting plastic carrier.

A pouch carrier, shown in Figure E-4, was designed to be made either as a die casting of aluminum or zinc, or injection molded of plastic. Quotes were obtained on these in lots of 10,000.

The quotes were:

Plastic	$0.855/unit
Aluminum	0.61/unit
Zinc	0.64/unit

It is apparent that the aluminum carrier is cheaper than either plastic or zinc. It is also lighter and has better heat transfer properties. The dimensional stability, after repeated use in the processing system, of a plastic carrier was thought to be questionable. Zinc has a disadvantage in that it is not as resistant to corrosion as either aluminum or plastic. The consensus was to proceed with an aluminum carrier.

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FIGURE E 1. POUCH CARRIER.

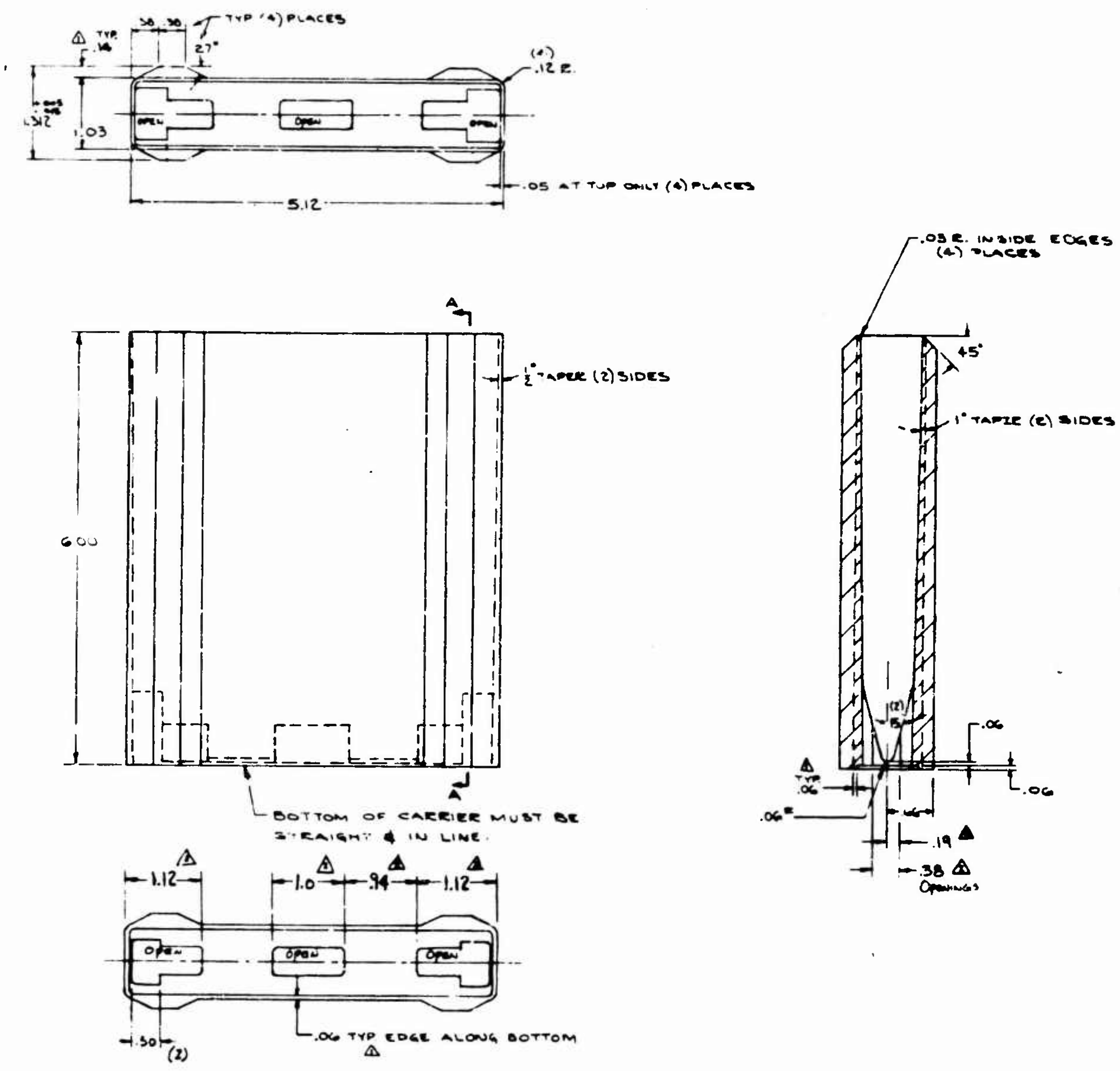


FIGURE E 2. POUCH CARRIER, FINAL DESIGN.

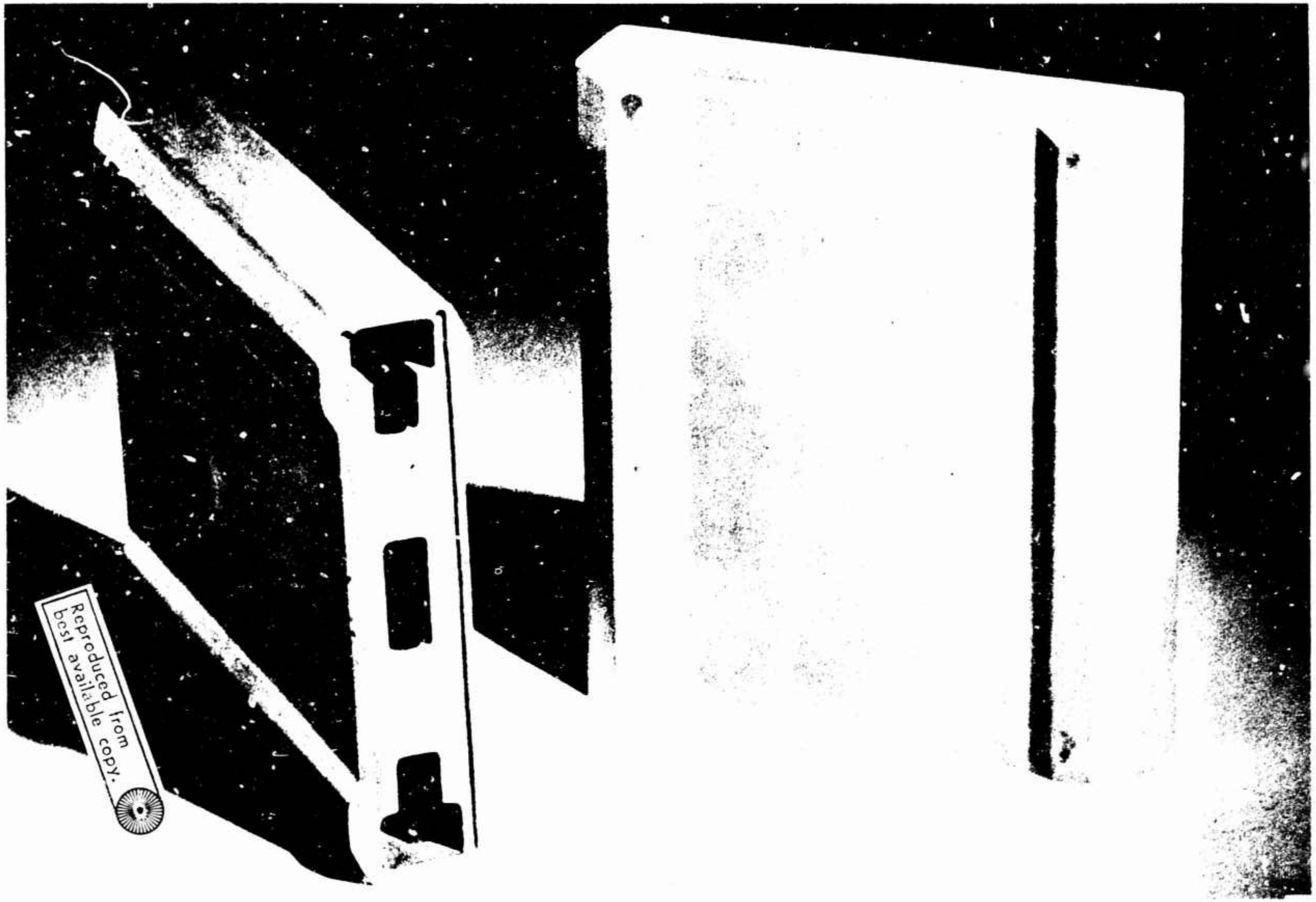


FIGURE E 3. POUCH CARRIER.

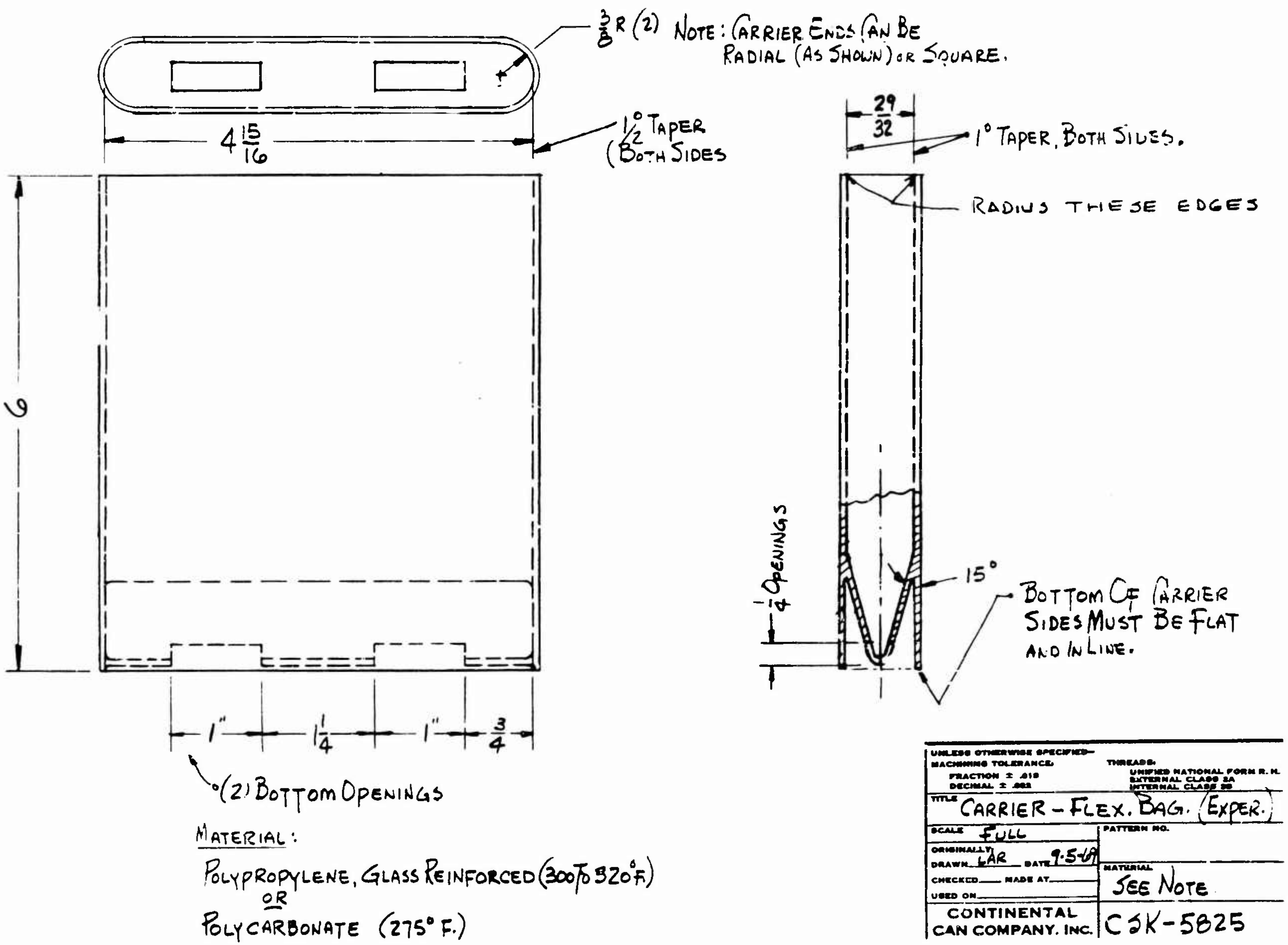


FIGURE E 4. POUCH CARRIER.

The pouch carrier was subsequently redesigned to be more compatible with the total processing and packaging system, and sample castings were manufactured.

The pouch carrier has been designed to accomplish the following without the need for specialized or totally new conveying and transfer systems:

A. Provide a means of handling and precisely locating the pouch (see Task D);

1. While moving the pouch from the form and fill module to the vacuumizing and heat sealing module.

2. While moving the pouch through the vacuumizing and final heat seal module.

3. When locating the pouch in relation to the heat sealing ba: in the final heat seal station.

B. Provide a means of confining the pouch during retorting (see Task EE) without affecting the process;

1. By establishing a uniform thickness for heat penetration.

2. By providing space for water circulation around and through the carrier during retorting (Figure E-5).

The retort rack, shown in Figure E-6 and Figure E-7 has been designed to accomplish the following:

A. To provide a container for twelve carriers (Figure E-5 and E-8) with filled pouches during the retort cycle.

B. To function as a magazine in feeding the carriers to the transfer module.

C. To provide a container for storing the carriers.

D. To nest for stacking on the retort cars.

Retort racks and carriers have been fabricated and tested in a retort at the CCC Technical Center to insure that proper temperature distribution was obtained throughout the retort. (See Task C.) The temperature differential was less than 2°F. at 250°F. The specification is plus or minus 1°F. Racks with carriers were then evaluated by Tasks A

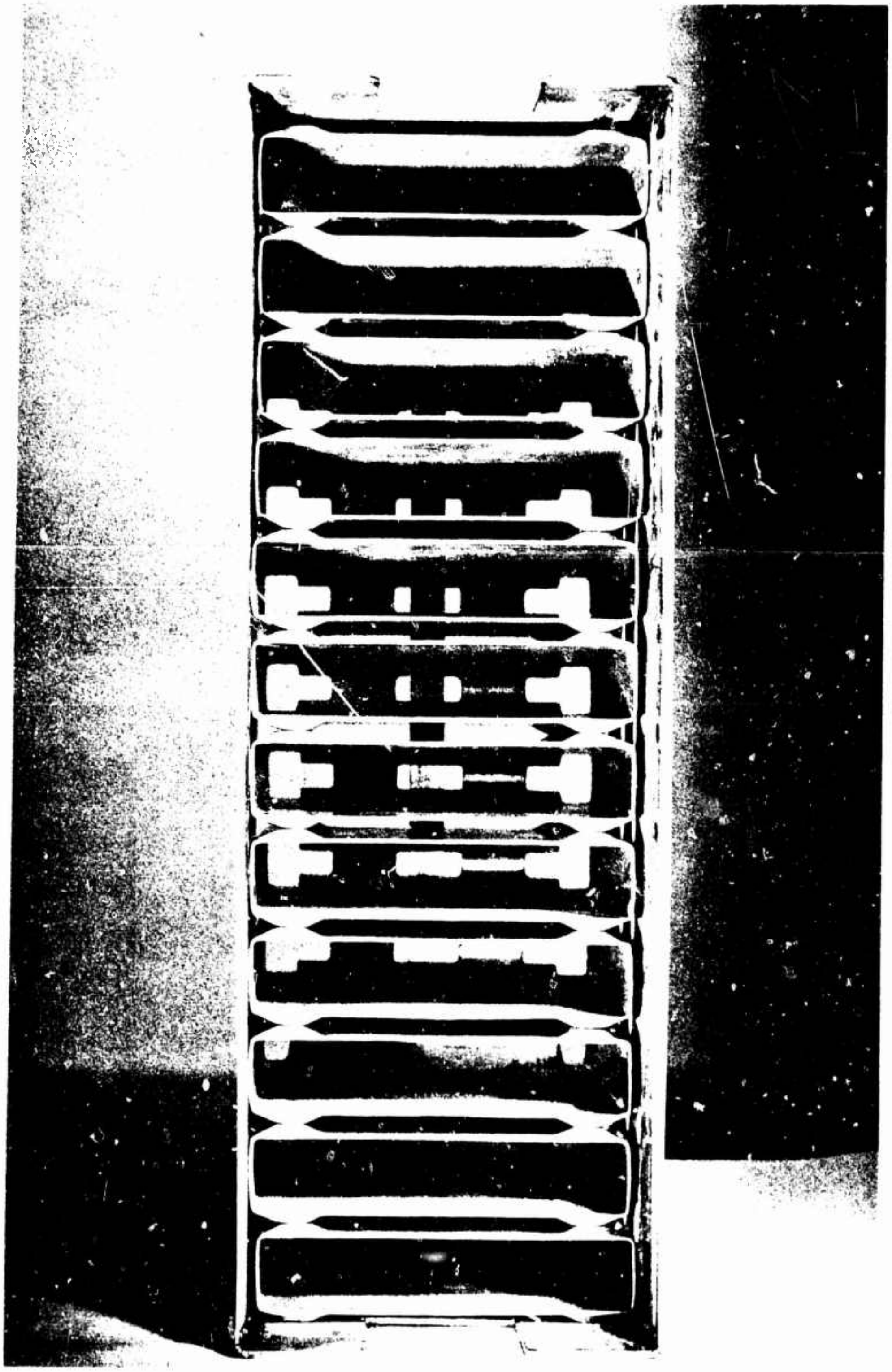
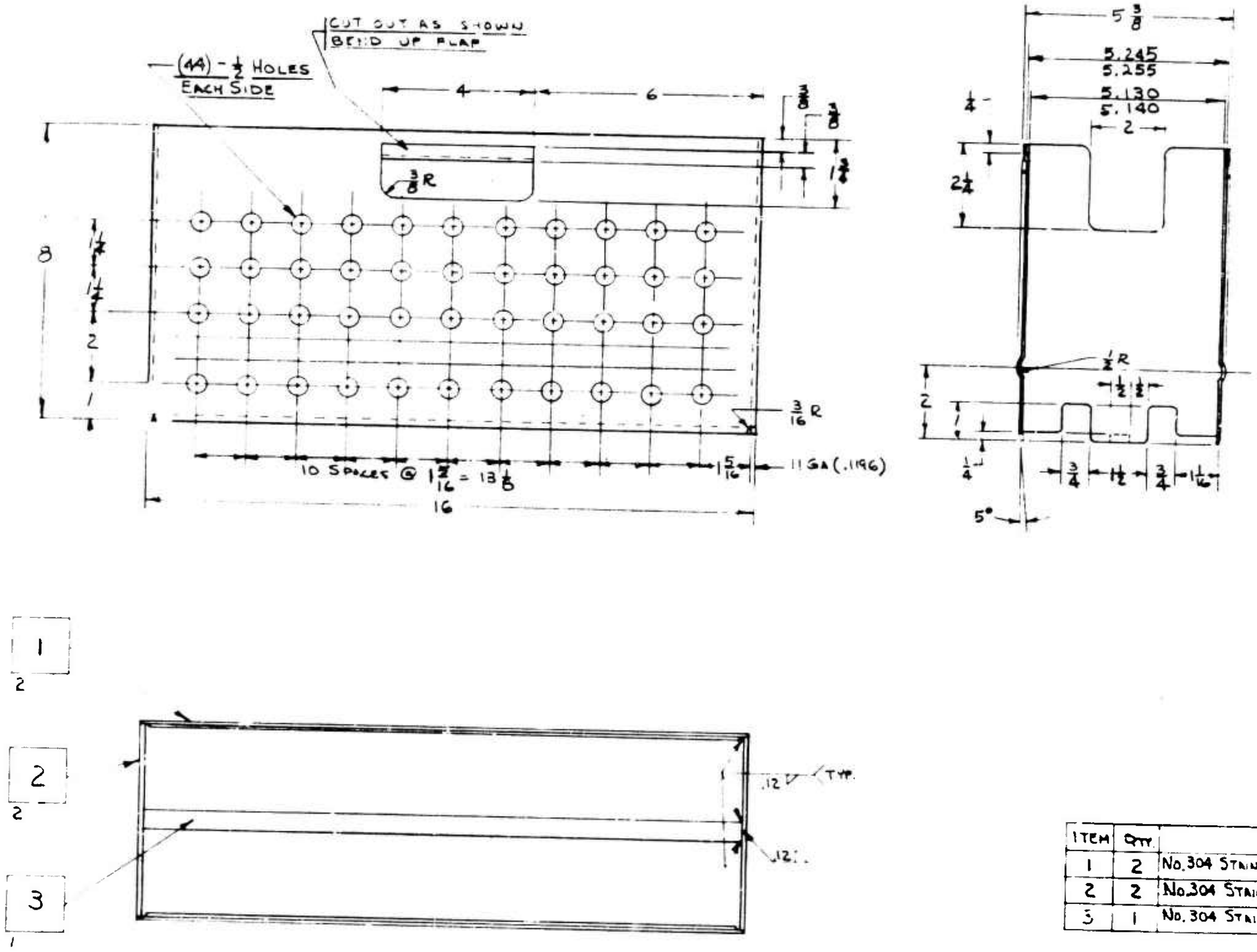


FIGURE E 5. RETORT RACK WITH EMPTY POUCH CARRIERS.



NOTE!
ALL RADII 1/4" UNLESS
NOTED OTHERWISE

ITEM	QTY	MATERIAL
1	2	No.304 Stainless Stl. Sht. 16GA(.0598) x 8 1/16 x 16 LG
2	2	No.304 Stainless Stl. Sht. 11GA(.1196) x 5 1/4 x 8 LG
3	1	No. 304 Stainless Stl. Flat 1/4 x 1/2 x 15 3/4 LG.

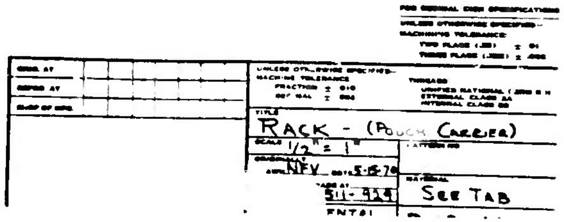


FIGURE E 6. RACK -- POUCH CARRIER.

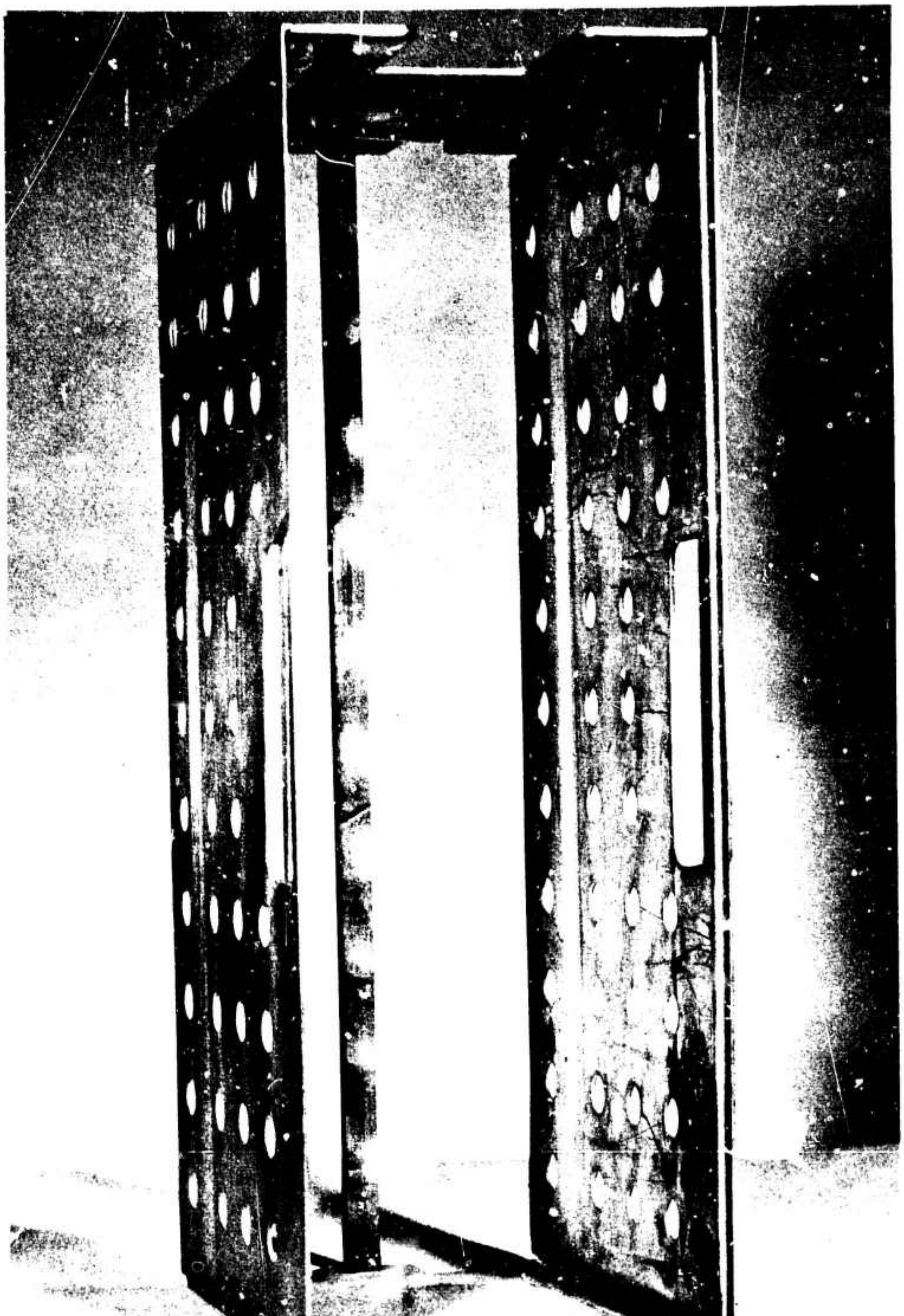


FIGURE E 7. RETORT RACK.

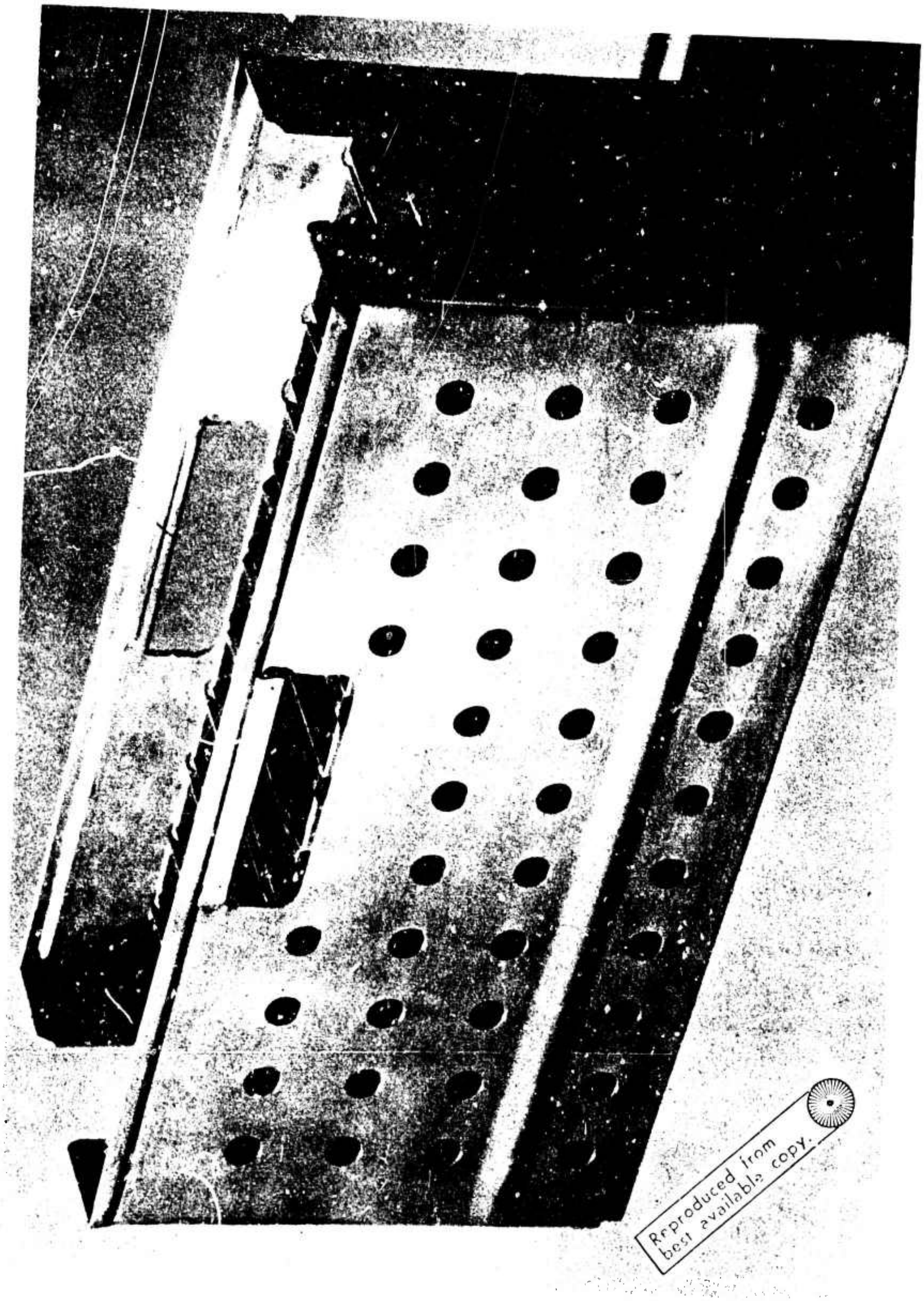


FIGURE E 8. RETORT RACK WITH POUCH CARRIERS.

and B. It was found that bakery products floated out of the carriers. A pouch hold-down device, made of perforated stainless steel, was fabricated, tested, and found to work satisfactorily. (See Figure E-9.) These will be provided in the production phase.

In the processing system, carriers containing filled, vacuumized, and heat sealed pouches will be discharged from the vacuum sealing machine onto a conveyor and conveyed to an accumulation table. From the accumulation table the carriers will be manually loaded into retort racks. The retort racks will then be manually loaded onto retort cars and the retort cars placed in the retort for processing.

Handling of Pouches After Processing

After processing, the retort cars will be removed from the retort; the pouches will be removed from the retort racks and passed through a drying tunnel to remove water from the pouch surfaces. The drying tunnel will be approximately twenty feet long, two feet wide, and five feet high. Heated air at approximately 120°F. will be blown on the pouches to remove the moisture. Capacity will be 30 to 60 pouches per minute. This unit would be similar in design to a unit now in production at Cranberry Products in Eagle River, Wisconsin.

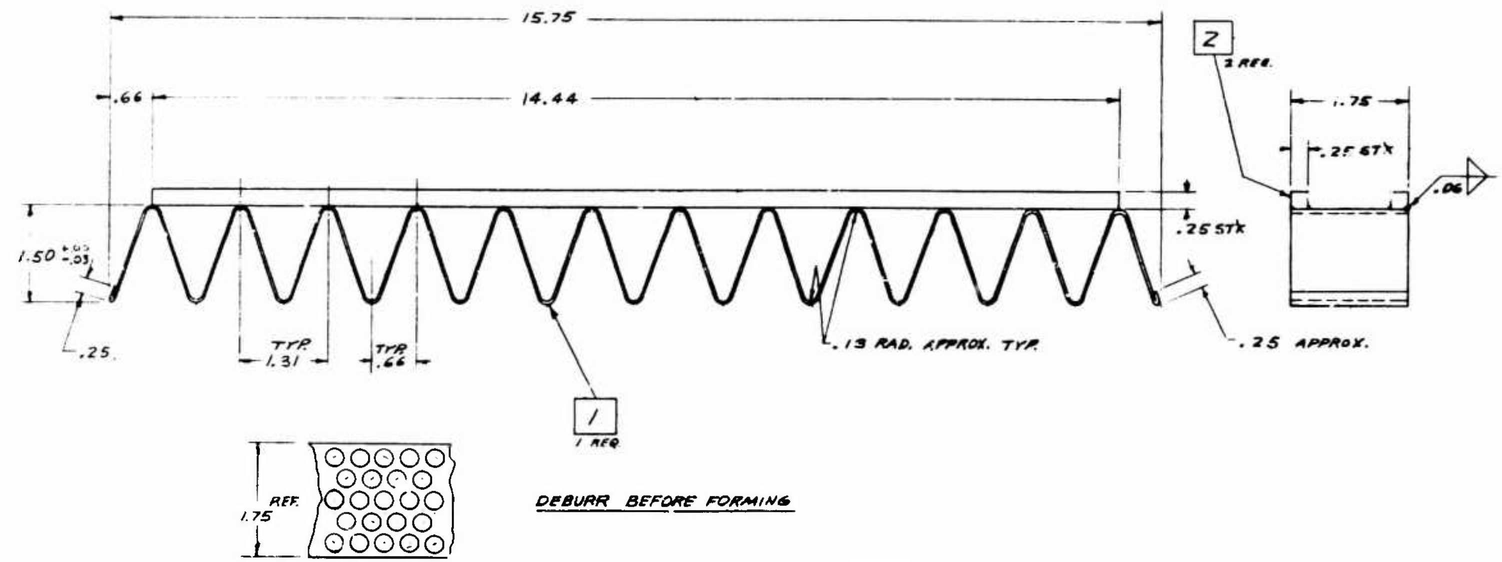
The pouches will be visually inspected for defects at the discharge of the drying oven and prepared for incubation.

For those pouches to be prepared for shipment after incubation the overwrap as received is cut to the desired contour and creased for forming into a container to hold the pouch. A fixture will be designed to manually form the overwrap, which is a known technique. Gluing and insertion of the pouch to the overwrap will be done manually.

An area will be provided for code stamping and inserting the packaged pouches into boxes and code stamping the boxes prior to shipping.

BILL OF MATERIAL

ITEM NO.	REQ'D.	MAT'L
1	1	AISI TYPE 304 STAINLESS STEEL SHEET 18 GA. (.0480) X 1.75 X 41.00 LG. PERFORATED WITH $\frac{1}{4}$ DIA. HOLES ON .38 STAGGERED CENTERS
2	2	AISI TYPE 304 STAINLESS STEEL $\frac{1}{4} \times \frac{1}{4}$ X 14.44 LG.



DEVELOPED LENGTH = 41.00 APPROX.

NOTE: WELDED CONSTRUCTION

LAST WELD DETAIL NO. 2

ALL WELD DETAILS SHOWN ON THIS DRAWING

FIGURE E 9. POUCH HOLD-DOWN DEVICE.

Task EE Technical Feasibility of Retorting

This task involved investigation of the feasibility of retorting and vacuum leak testing thermoprocessed food in flexible pouches. Based on criteria established under Tasks A, B, and C, it has been demonstrated that retorting these products is feasible with certain modifications to normal retort operation. Vacuum leak testing has not been demonstrated as being feasible, however. It is recommended that the retort design including modifications as discussed in this report be used in the production phase of this contract. It is not recommended that vacuum leak testing be used as a method of inspecting pouch integrity for all products. This is discussed in more detail in this report.

Retort process and modifications

Investigations of the feasibility of retorting were conducted using the criteria established under tasks A, B, and C of this contract. These criteria include retort time/temperature/pressure limitations throughout the retort during come-up, processing, and blow-down. The most critical criteria during this retort cycle were found to be:

a. Control of the pressure differential between positive pouch pressure and retort pressure to 0 to 2 psi for bakery products,

b. Maintaining the uniformity of temperature throughout the retort to ± 2°F. during come-up and blow-down and to ± 1°F during the cook cycle.

c. Closely controlling the rate of temperature change during come-up and blow-down to a rate of 8°F/minute for bakery products to achieve proper texture of these products and insure integrity of the pouch.

These criteria have been demonstrated as being feasible using the modifications as described under "Retort Operation" and "Equipment Specifications" below:

Retort Operation

Pouches and product are handled through the filling and sealing machines in small die-cast aluminum carriers as described under Tasks D & E. Forty two racks for bakery items or 66 racks for non-bakery items are placed onto a retort car (shown in Figure EE-1) which is then loaded into the retort. An additional castered dolly is required to raise the retort cars to the height of the rails in the retort (see Figure EE-2). Four cars are required to fill the retort making a total of 2,016 pouches for bakery items or 3,168 pouches for non-bakery items in each retort batch. After loading the meat products no additional operation is necessary before the retort door is closed. With the bakery products, however, a sample of the same lot of dough must be placed into a pressure sensing device on the inside of the retort. A more complete description of this

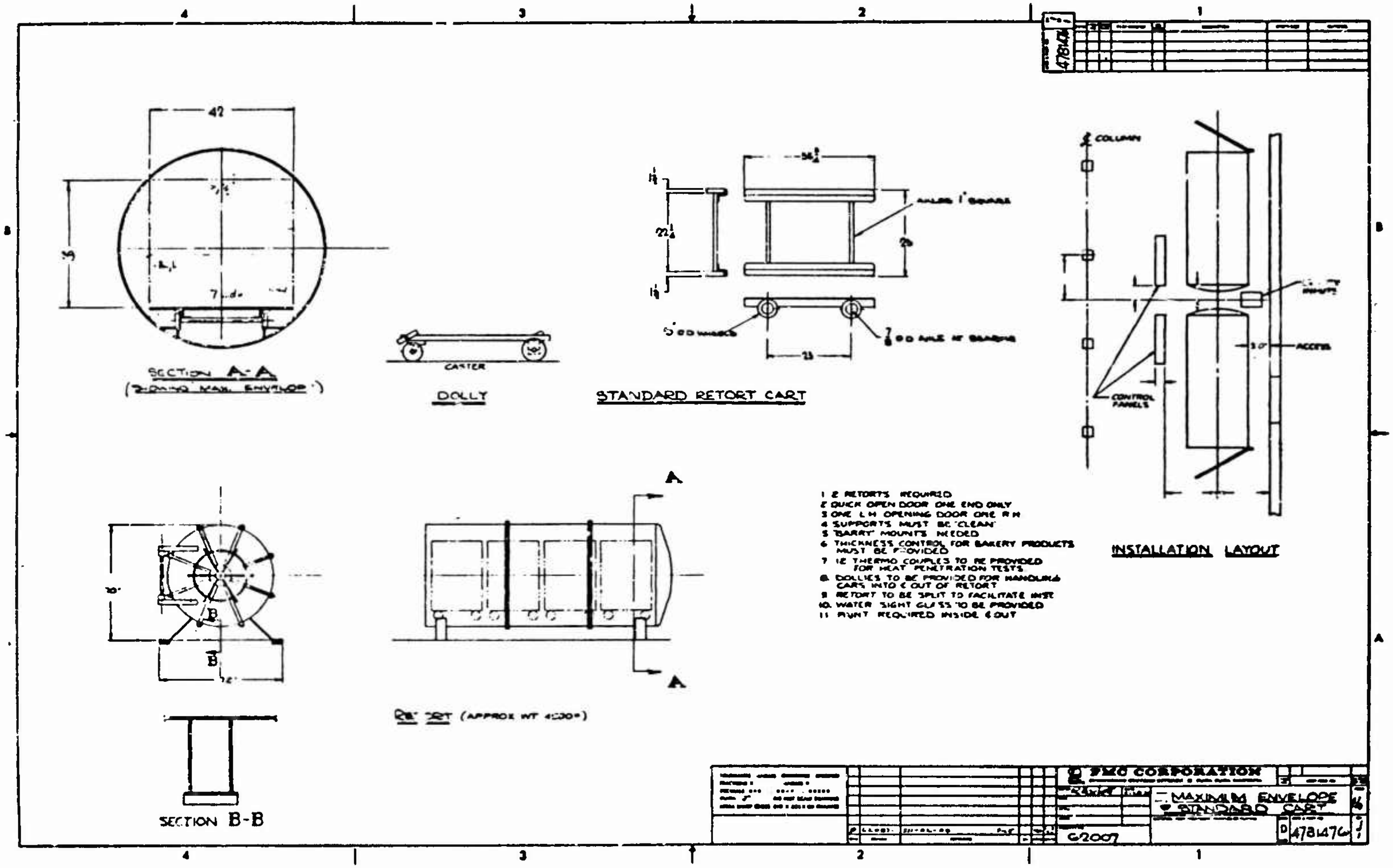


FIGURE EE 1. RETORTS AND RETORT CARTS.

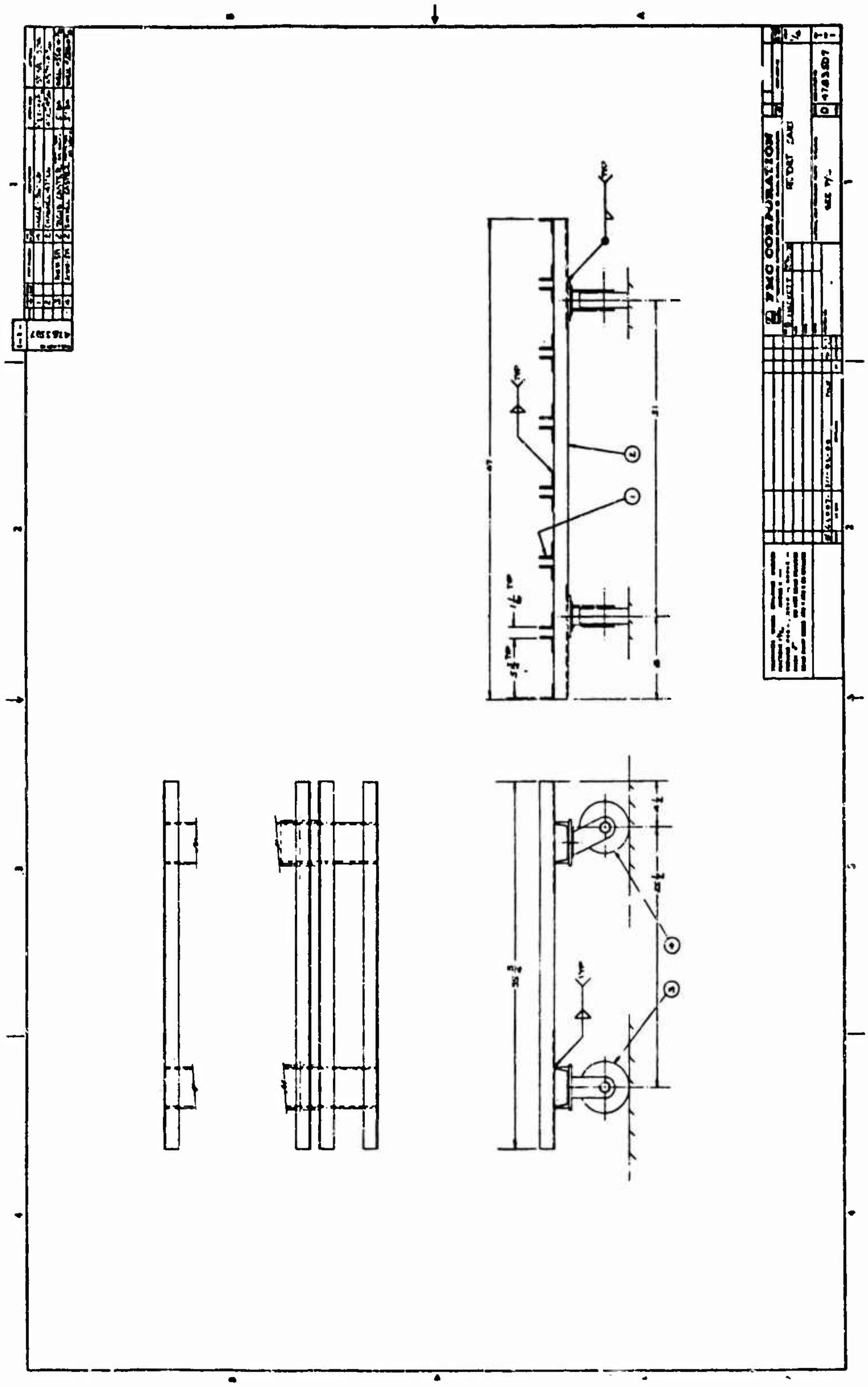


FIGURE EE 2. RETORT CART.

pressure sensing device is given under the description of the pressure sensing device (see 4 below). The quick opening door is now closed and locked (see Retorts and Retort Carts, Figure EE-1). The digital programmer is started and the sequence of events (shown in Figures EE-3 or EE-4) starts automatically for meat or bakery products, respectively.

Water is pumped into the retort to cover the retort racks. Steam is then introduced through three steam headers at the bottom of the retort to start the "come-up" phase of the operation. The rate of temperature increase in the retort is controlled precisely by a cam controller. The cam ensures that both the total "come-up" time and the rate of temperature increase falls within the pre-established limits. With the bakery products, pressure within the pouch is not only dependent upon the temperature, it is also dependent upon the amount of leavening agent in the product formulation. Because the positive differential pressure inside the pouch must be held within 0 to 2 psi over the pressure of the retort, a pressure sensing device as well as a temperature controller is utilized. Either one of these monitoring devices can modify the "come-up" operations by increasing the heat input or the overriding air pressure. To ensure that constant heat distribution is maintained throughout the retort and not only at the sensors, air is bubbled through the water and a pump is used to recirculate the heating water. After the cooking temperature is reached, the steam inlet is throttled down to maintain this predetermined temperature which varies with meat, bakery, and pineapple products. The cooking cycle time is started at this point by the programmer and the cooking temperature is maintained for this required length of time which varies with the type of product The precise controlling of the "blow-down" curve requires that both the hot water outlet and the cold water inlet must be governed by controls according to a predetermined program. The overriding air pressure must also be controlled accurately during this phase of the operation. Product is now completely processed and can be removed from the retort.

Equipment Specifications

1. Retort Cars and Dollies

   The retort car shown in Figure EE-2 consists of a stainless steel frame equipped with four rimmed wheels, two fixed and two castered, for ease of movement onto the retort rails. Cross angles are positioned to ensure accurate guidance for the pouch racks and thereby control the spacing of the racks on the cars.

   Wheeled dollies of similar construction to the cars will be used to handle the loaded cars when they are out of the retort.

2. Retort Size

   The original retorting concept called for one retort 5′ 0″ diameter by 24′ 0″ long, with a capacity of approximately 6,000 pouches. To accumulate this number of pouches at a rate of 60 per minute would require approximately 82 minutes. The

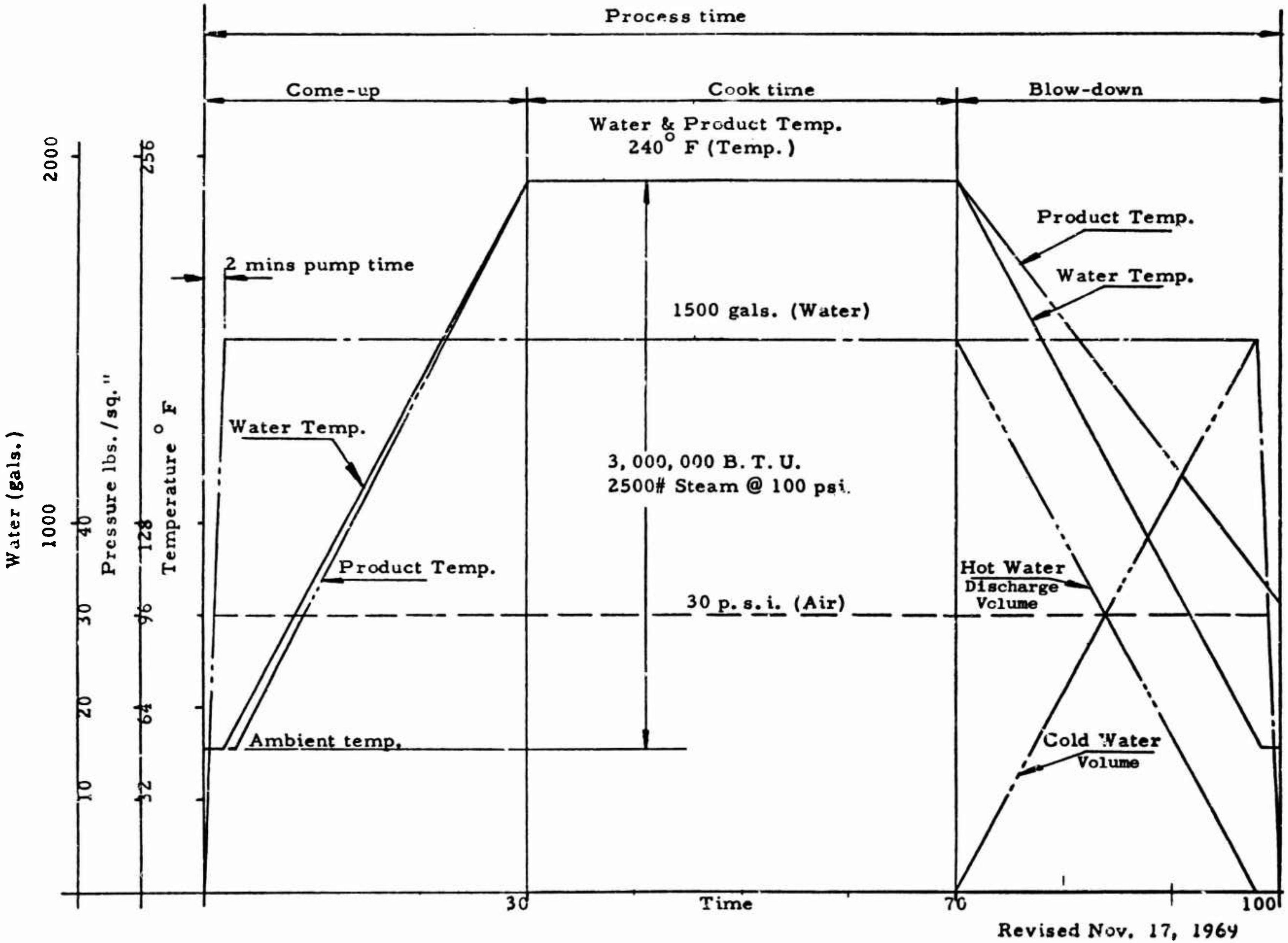


FIGURE EE 3. Graph showing sequence of operations in a typical meat product cooking process.

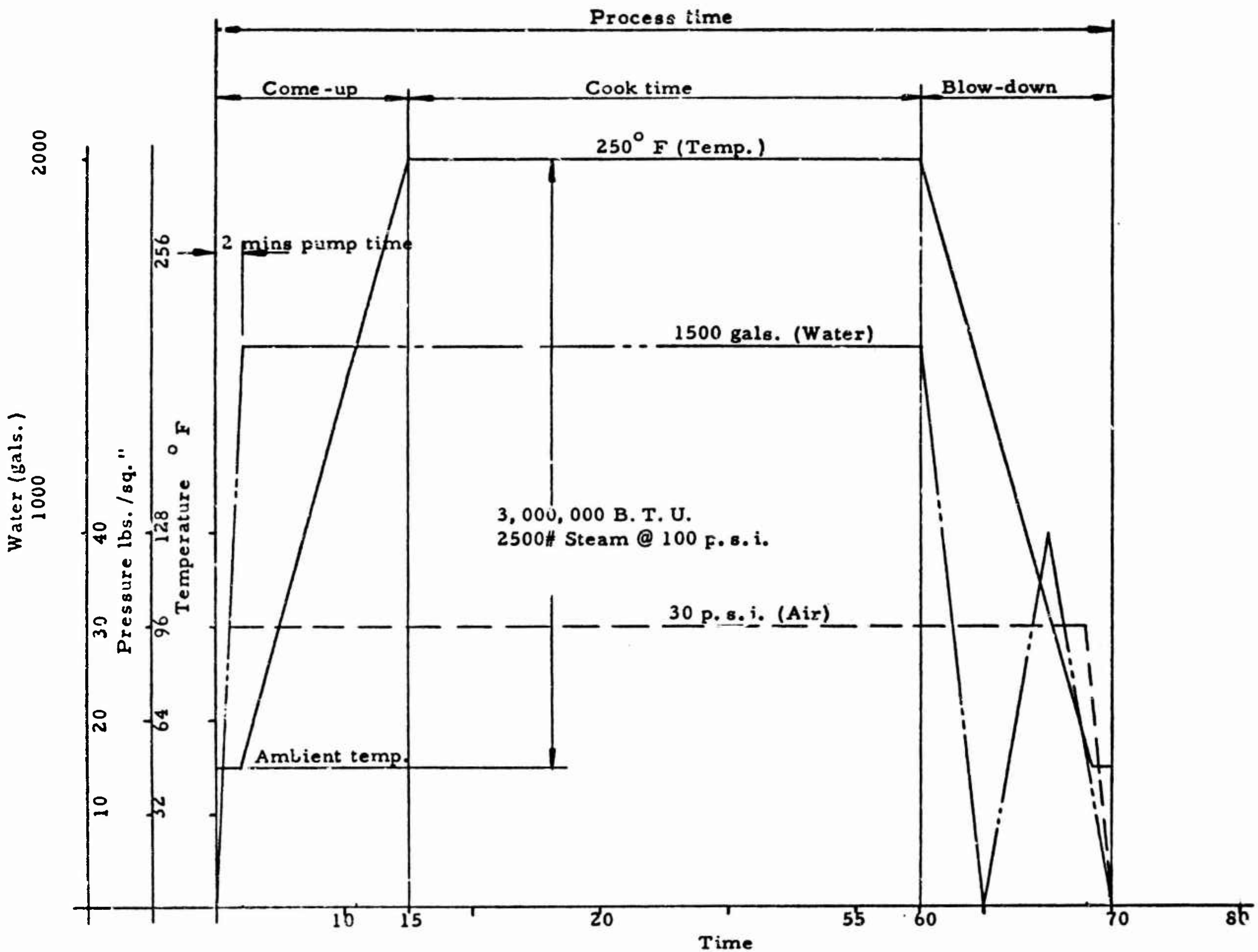


FIGURE EE 4. Graph showing sequence of operations in a typical bakery product cooking process.

pouches first produced would require "in process" cooling for bakery items and maintaining of hot fill temperatures for meat items which would complicate the operations. Two retorts would solve this problem and are, therefore, recommended. To facilitate the installation of the retorts they must be sectionalized. Because of the critical heat distribution requirements it would be advisable to space out the pouches and racks as much as practical to allow a free flow of heating water. Therefore the length of the retorts should be approximately 12' 0" split into three sections for transport and installation purposes. This length also increases the water to product ratio which increases the available heat which is also an advantage. It is recommended that two retorts approximately 12' 0" long and 5' 0" diameter with proper controls be used.

3. Automatic Controls

The operation of the water temperature, air pressure, bubbling air circulation and recirculating pump systems will be directed from a central control console which is commercially available

The Digital-Set Programmer would be set to open and close the steam supply valves and air valves, to turn the recirculating pump on and off, and to vent the overriding air and hot water according to the preselected program. In bakery products where adjustment of the overriding pressure is required to compensate for the pressure within the pouches being processed, a separate pressure sensor and control is provided to adjust the override air pressure.

4. Pressure Sensing Device

A method of controlling the override retort pressure to conform to the pressure inside the pouch within 2 psi positive pouch pressure was developed and proven successful. A closed container with a volume equal to a filled pouch was filled with product from that being processed (see Task B, Figure B-4). A pressure sensing element measured the pouch equivalent pressure in the closed container and regulated the overriding retort pressure to within 2 psi below the pouch pressure using a differential pressure transmitter manufactured by Honeywell and a Taylor pressure controller.

5. Overriding Air System, Water System, and Steam System

Controls, valves, and headers are conventional equipment and the design, sizing, and selection will be achieved in the next phase of the program.

6. Packing Gland

In order to obtain accurate temperature readings throughout the retort, thermocouples will be used. These thermocouples are standard units and may be purchased from Pyco Industries, Inc. A potential problem area is the packing gland required to allow the thermocouple leads to come out of the retort. A packing gland manufactured

by Pyco Industries, Inc., (shown in Figure EE-5) has been obtained and tested and found satisfactory. The gland with the thermocouple leads inserted was placed in oil and heated to 260°F. Air at a pressure of 45 psi was introduced to one side of the gland and the oil observed for leaking air. This test was continued for two hours with no leakage. This gland proved to be satisfactory and will be used in the actual retort.

7. Air Agitation and Water Recirculation

Commercial experience has shown that constant temperature throughout a retort can be accomplished by either bubbling air through the heating water or by circulating the heating water with a pump. Because of the extreme requirement of temperature uniformity for bakery items, both methods will be used.

Vacuum Leak Detection

One method with potential for production line use to establish the integrity of the pouches after retorting is the vacuum leak test method. This would involve submerging a number of the pouches in de-aerated water in an airtight chamber. A vacuum would be pulled and the water scanned for bubbles. To demonstrate the feasibility of this approach, a hole size of .0015 inches was established as a standard for testing. Eighteen sample pouches with a standard hole (.0015-in. dia.) were prepared.

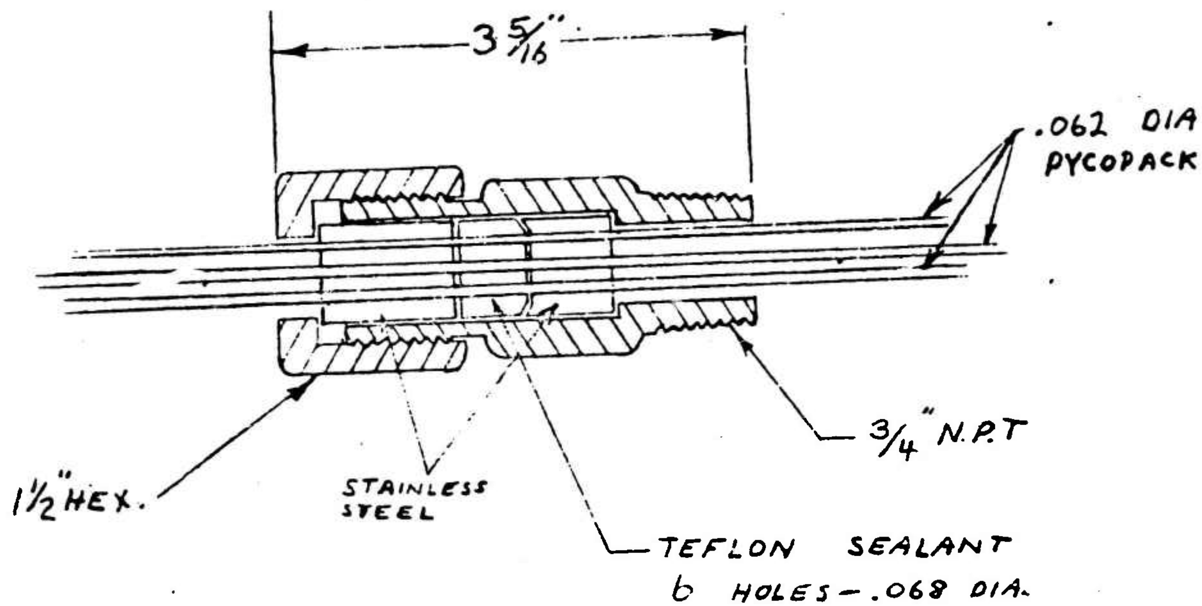
The first pouch was submerged in the water, and a vacuum of approximately 29 inches of mercury was pulled in the chamber. No visible signs of leakage were observed. The possibility of product blocking the hole was eliminated in the next sample by filling the pouch with marbles and repeating the experiment. Again no visible signs of leakage were observed.

A second approach was the use of an Infra-Red radiation thermometer. The pouch and product were heated to approximately 90°F and the aluminum laminate material of the pouch was quickly cooled. The pouch was then quickly scanned to detect the difference in heat radiation from around the .0015-inch diameter hole and the rest of the pouch surface. No leakage was detected.

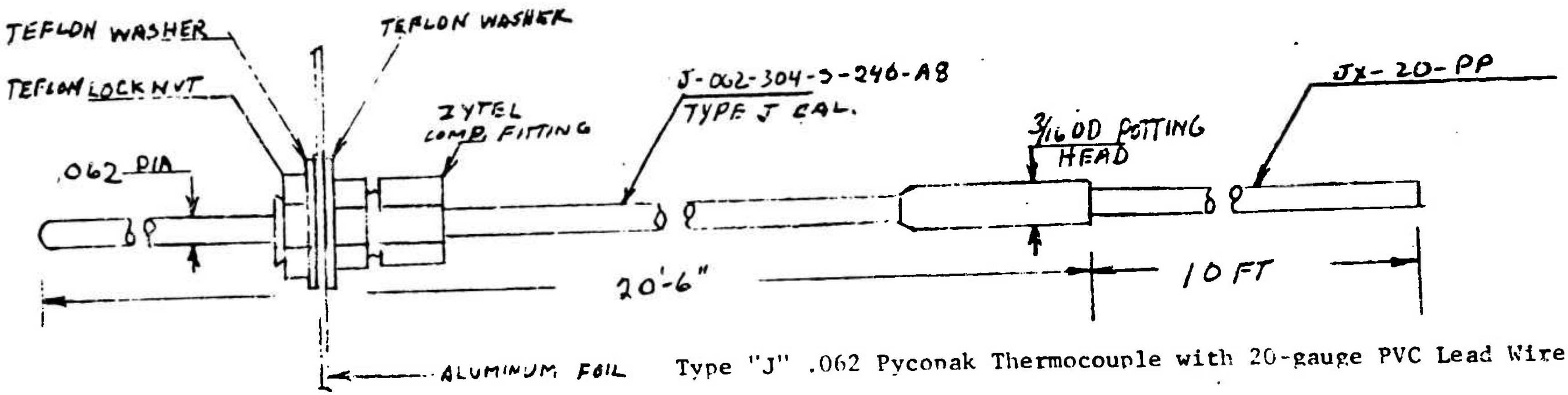
Helium in conjunction with a mass spectrometer was also considered. Two pouches containing different products and having the standard .0015-inch diameter hole were given to Bell and Howell for tests in their laboratory. No positive results were obtained.

Schematic drawings of two proposed vacuum leak detection chambers are shown in Figures EE-6 and EE-7.

As of this time no satisfactory rapid, production line method of detecting a hole of .0015-inch diameter in foil pouches has been established for fluid or "wet" products having low levels of residual gas.



Multi-Hole Packing Gland



Type "J" .062 Pyconak Thermocouple with 20-gauge PVC Lead Wire

FIGURE EE 5. PACKING GLAND COMPONENTS.

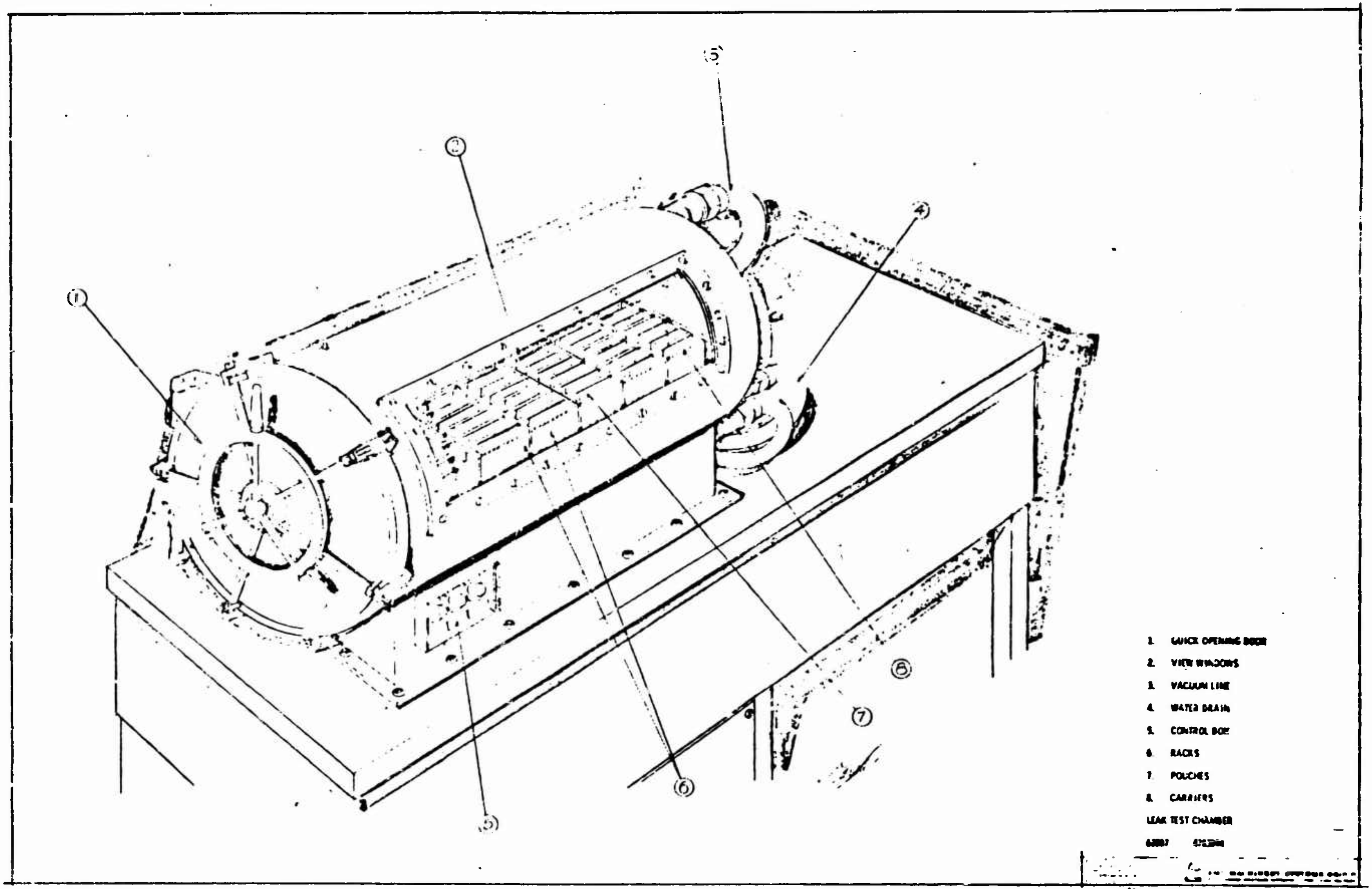


FIGURE EE 6. PROPOSED LEAK TEST CHAMBER 1.

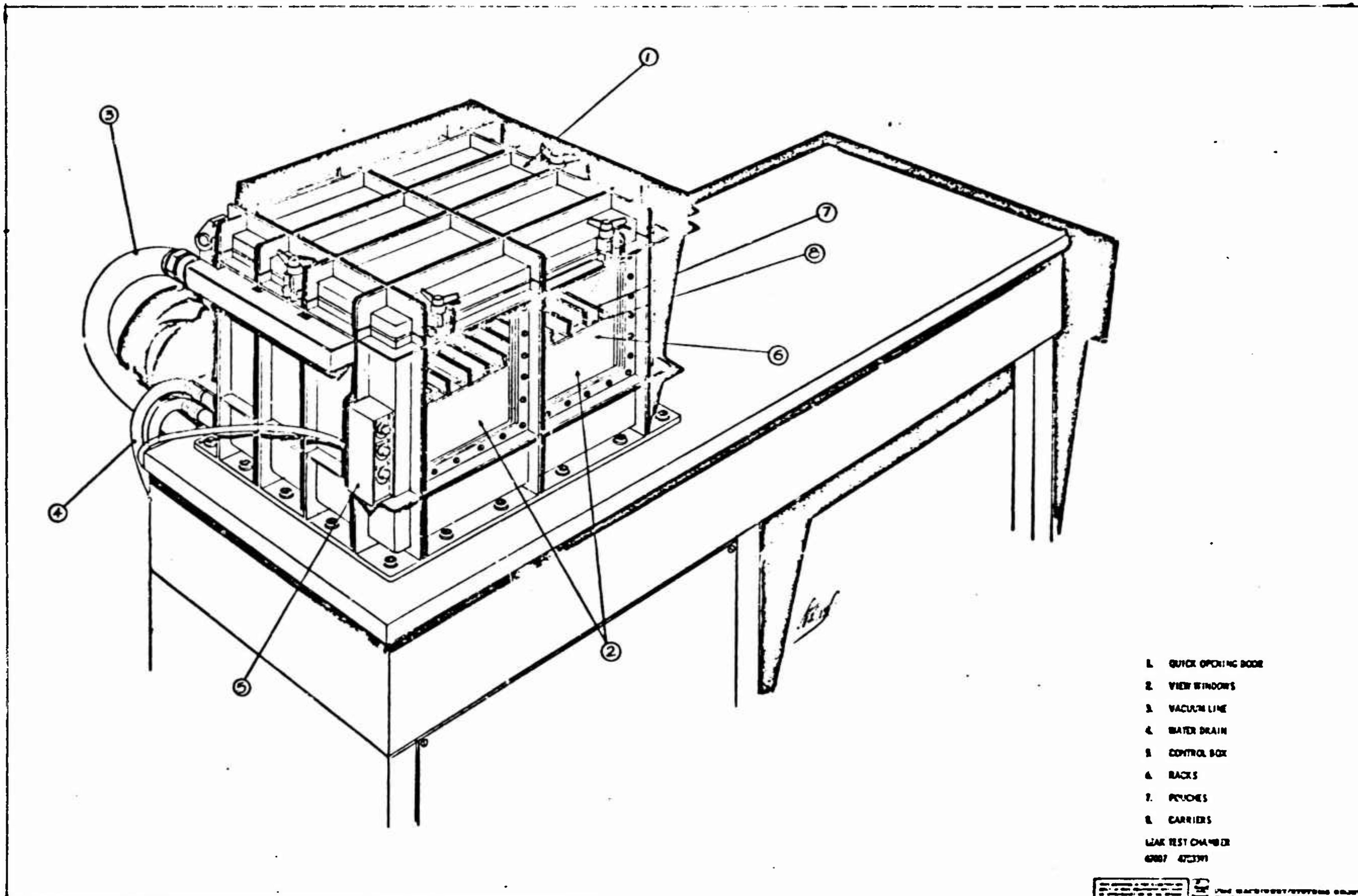


FIGURE EE 7. PROPOSED LEAK TEST CHAMBER 2.

Task H System Component and Installation Acceptance

This task concerns evaluation of the technical feasibility of the packaging and processing modules of the system. The general criteria for acceptance are shown in "Tentative Specification Guide Lines for Natick Contract DAAG-17-69-C-0160", see Task "C". It is understood that feasibility can be established either by actual demonstration in conformance with the specification referenced or subjective evaluation of known prior art, bench models, or calculation.

The various components of the system were identified as modules to aid in organizing the findings.

MODULE 1 is the flexible laminate roll stock used in this process, described in Task "C". It was concluded that the specifications for this material are satisfactory for the intended functions, performing properly as a package for the foods packed, and being amenable to all requirements of the system. It is recommended that the specifications tabulated in Task "C" be considered suitable for use in the production phase of the program.

MODULE 2 is the Bartelt machine pouch forming and cut-off sections. It was concluded that these portions of the Bartelt machine are satisfactory for their intended purposes, and it is recommended that they be incorporated for the production phase.

In the course of manufacturing thousands of pouches on the form, fill, and seal machine during Phase I, problems were encountered with control of seal temperature and pressure which resulted in variable pouch performance in the burst test. These problems were resolved (Task "DD").

MODULE 3 (pouch transfer from pouch forming to pouch opening); **MODULE 4** (pouch opening); **MODULE 5** (pouch filling) were not statistically tested during Phase I, since such evaluations should be performed on in-line operations rather than on bench models. Even though a more complete system was developed to gain further confidence of judgement, as reported under the appropriate tasks for these Modules, there was insufficient time to accomplish statistical evaluation of these Modules. Based on judgment, feasibility was demonstrated to the extent that progression to the production phase is unequivocally recommended. Statistical evaluation will be performed on these modules prior to production runs during the production phase.

MODULE 6 is the pouch shaping mechanism. Its function is to shape the filled pouch so that it readily assembles with the pouch carrier. No model was made of this device because it was thought that a number of known type mechanisms (belts, moving plates, etc.) could be readily adapted for this purpose, should it be necessary.

MODULE 7 is the Partial Seal section. This module was listed when there was some concern about the possibility of seal contamination during transfer of the filled pouch to the pouch carrier. Our present concept of assembling the carriers onto the

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pouches when the pouches are under control of the chain in the transfer module has essentially removed the cause for concern, and it is believed the Partial Seal section will not be necessary.

MODULE 8 (pouch transfer from form and fill machine to pouch carrier and conveyor); and MODULE 9 (Vacuumizing and sealing unit) were not statistically tested during Phase I for the same reasons stipulated for MODULES 3, 4, and 5. Feasibility was demonstrated to the extent that progression to the next phase is recommended.

MODULES 10 and 11 are the Pouch Transfer and Placement in Retort Rack sections. These operations are manual, and it was concluded that no substantiating work needed to be done to establish feasibility. The production phase should be pursued on the basis of the concept mentioned.

MODULE 12 is the Retort. The long history of retort experience available to the consortium narrowed the work necessary for feasibility determination considerably. Control of over-riding pressure and temperature during come-up was particularly critical on the bakery items. Work done by FMC in this area, based on Pillsbury's requirements, is considered adequate to justify a recommendation to proceed on this basis to the production phase. See Task "EE".

MODULE 13 is the Pouch Drying section. A commercial unit has been observed in operation performing a similar function (Cranberry Products Co., Eagle River, Wisconsin), and there is no need to do further work to establish feasibility of such a device. A similar unit can be tailored to suit the requirements of the production phase, and this is recommended. See Task "E".

MODULE 14 is the Pouch Inspection section. Task "EE" reports on the problems encountered with the proposed vacuum leak test. The feasibility of vacuum testing has not been demonstrated for production-line use. The biotester is not considered a production method because of its slow speed and philosophical objections to subjecting a clean package to intentional bacterial contaminations prior to use.

It is recommended that neither the vacuum leak test nor the biotest procedure be considered adequate for suitable for this program.

Task K Packaging, Processing, and Food Quality Assurance Programs

The principal purpose of this task was to establish all test and inspection procedures necessary to provide the assurance on a sound statistical basis that the thermoprocessed shelf-stable foods in those flexible packages produced in this contract meet the reliability requirements of this contract. Further, it is a requirement of this task to compile and report all test and inspection data in a manner appropriate to the above principal purpose.

Reliability and Testing

We will determine the feasibility of the finalized production system for reliably preparing packages of thermoprocessed foods. In the production phase we will establish the reliability of the system. Reliability is defined as the ability of the total production system to produce sound, defect-free packages of each food item over a significant test production period(s). The number and length of the test period(s) will be established on awareness of the mean production rate and be approved by the Contracting Officer. The total quantity per item will be not less than 50,000. In addition to the absence of defects, the packages and contents will meet minimum organoleptic acceptance, net weight, seal strength, and residual gas requirements. It should be noted that, presently, the residual gas level is desired to be 10 cc or less; however, higher levels will not be reason for rejection of packages.

Defects include leaks or discontinuities in the body or seal areas, significant seal wrinkles, delamination of laminate layers, and contamination of interior seal area surfaces with solid or fluid product, grease, water, and/or any other foreign material.

Samples from production test runs will be removed, visually inspected for workmanship and presence of defects, and tested to establish that end item requirements (Table K-I), seal and burst strengths, are met. It is estimated that two sample withdrawals will provide adequate materials for the necessary tests. Sampling will follow MIL-STD-105D utilizing inspection level S-3 and an AQL of 6.5 (normal inspection).

An additional representative sample will be visually inspected for workmanship and presence of defects and then incubated at controlled temperatures to ascertain the commercial sterility of the product. Inspection Level S-4 of MIL-STD-105D will be used with an AQL of 1.0.

An additional representative sample of 6 pouches per lot will be utilized for flavor panel evaluation. Values will be applied to the product by each tester utilizing the nine-point hedonic scale. A lot is defined as the pouches of thermoprocessed foods, assembled in eight consecutive (but not necessarily continuous) hours of production.

TABLE K-I

END ITEM REQUIREMENTS

ITEM	MIN.	AVG.	MAX.
1. Beans in Tomato Sauce			
Container content in ounces	4.5	4.75	5.25
Drained weight (after 10 days)	2.75	3.25	
Acceptability*	No off flavors or odors		
2. Beef Loaf			
Container content in ounces	4.5		5.5
Meat count, unbroken loaf	1		1
Acceptability*	No off flavor or odors		
3. Beef Steak			
Container content in ounces	4.5		5.5
Meat amount in ounces	4.25		-
Meat count	1		1
4. Beef Stew			
Container content in ounces	4.5		5.5
Meat amount in ounces	1.5		-
Meat count, chunks	2		
Potato count, pieces	2		
Carrot count, pieces	2		
Lima bean, count (whole)	8		
5. Beef Slices in Barbecue Sauce			
Container content in ounces	4.5		5.5
Meat amount in ounces	2.25		-
Meat count, slices	2		2
pH	4.9		5.1
6. Chicken Ala King			
Container content in ounces	4.5		5.5
Meat amount in ounces	1.25		-
Meat count, chunks	15		30
Peas, pieces	10		-
Mushrooms, pieces	4		
Pimientos	10		

*Applicable to all items

TABLE K-I (Cont'd)

END ITEM REQUIREMENTS

ITEM	MIN.	AVG.	MAX.
7. Chicken Loaf			
Container content in ounces	4.5		5.5
Meat count, unbroken loaf	1		1
8. Ham and Chicken Loaf			
Container content in ounces	4.5		5.5
Meat count, unbroken loaf	1		1
9. Frankfurters			
Container content in ounces	4.5		5.5
Meat amount in ounces	4.25		
Meat count	4		
10. Ground Beef in Pickle Flavor Sauce			
Container content in ounces	4.5		5.5
Meat amount in ounces	2.75		-
pH	4.9		5.1
11. Pork Sausage			
Container content in ounces	4.0		5.5
Meat amount in ounces	3.25		-
Meat count	4		
12. Pineapple in Syrup			
Container content in ounces	4.25	4.50	5.0
Drained weight (after 10 days)	3.1	3.50	
Syrup cut-out °BRIX (after 10 days)	30		
13. Fruit Cake			
Container content in ounces	-		5.5
Moisture content %			18
Fruit and nut distribution	Uniform and identifiable		

TABLE K-I (Cont'd)

END ITEM REQUIREMENTS

ITEM	MIN.	AVG.	MAX.
14. Orange Nut Cake			
Container content in ounces	-		5.5
Moisture content in %			17.0
Peel and nut distribution	Uniform and identifiable		
15. Pound Cake			
Container content in ounces	-		5.5
Moisture content %			18.0
16. Chocolate Nut Cake			
Container content in ounces			5.5
Moisture content %			12.0
Distribution of nuts	Uniform and identifiable		
17. Bread			
Subjective judgement by those skilled to make evaluation			

All remaining pouches (100%) from production test runs will be inspected visually for workmanship and presence of defects. Following the visual examination, we will subject the production samples to an incubation test for a time and temperature agreed upon by the Contracting Officer. Periodically these storage samples will be examined for leakers or swells. A running record will be maintained recording any positive samples. The process average will be calculated.

Specific Quality Assurance Programs

It is the intent that the specific programs delineated herein will apply in principle to the reliability of any system, including food quality assurance, employed in the production of thermoprocessed, shelf-stable foods in flexible pouches.

I. Package Materials

a. Raw Material Procurement and Inspection — Plant Level

Commercial 50-gauge polyester, 35-gauge aluminum foil and 3-mil polyolefin will be procured, inspected, and tested against established raw material specifications. Any nonconforming stock will be rejected and replaced with specification level material.

b. Flexible Laminate Structure Fabrication and Testing — Plant Level

Using established standard laminate fabrication processes, the specified web materials will be produced on production equipment to meet specification requirements (Task C) as demonstrated by proven plant tests for laminates which include the following:

1. Color matching
2. Bond strength
3. Seal strength
4. Adhesive weights and continuity
5. Residual solvents
6. Odor
7. Retortability

c. Incoming Sampling and Inspection

This applies to the laminate of polyester/foil/polyolefin received at the food packaging plant and as produced in the Flexible Packaging Division of Continental Can Co., in Mt. Vernon, Ohio.

1. Each roll of laminate received shall have a production or manufacturing number (preferably sequential) and shall be accompanied by a certification that the roll meets plant specifications.

II. Equipment Acceptance Testing

Since bench modeling in Phase I was limited to that necessary to judge feasibility and to permit a decision on progression to the production phase, no formal module or equipment acceptance testing was performed. There are basically three testing situations that must be performed in the production phase:

1. Testing to gain assurance that individual pieces of equipment and operations are performed well enough to justify assembly and running the entire line.

2. Testing to assure that certain end item requirements are being met (net weight, seal strength, etc.)

3. Lastly, and most important of all, testing to determine the ability of the entire system to manufacture defect-free packages.

Tasks C and H have established a series of 14 modular inspection stations for the logical evaluation of the complete packaging system. This provides assurance prior to final assembly that all parts of the system will have been considered and none overlooked. For the purpose of statistical acceptance testing and reliability prediction, it is not necessary to test for critical defects at each modular inspection station, but at selected strategic points in the line so as to reflect the capability of combined modules of producing defect free packages.

At present the pouch burst test (Appendix) is accepted as the most demanding of pouch integrity and reflects seal as well as overall pouch performance. Seal strength test (Appendix) is of secondary importance to pouch burst test and is used to help elucidate any failure in the pouch burst test.

Inspections to be made at each modular station are stipulated in Tasks C and H. For the purpose of acceptance testing for Task H reliability evaluation, modules have been combined in Task K to form specific test stations. At each specified test station which defines a unit operation, the critical defect test to be performed is the pouch burst test (Appendix). Sampling for test purposes requires that 3 to 5 lots be taken, each consisting of 30 consecutive pouches produced under conditions simulating selected production rates which will range between 30 and 60 units per minute.

Each lot of 30 consecutive pouches is produced under conditions simulating line start-up of a full-scale production operation.

One or more pouch failures by the pouch burst test is cause for rejection of the defined unit operation as not likely to meet the reliability goal of the contract.

Acceptance tests and inspections are performed under direct supervision and become a record of Task H.

The rationale for selecting 30 consecutively produced pouches from 3 to 5 production lots, as appropriate for predicting reliability of the process at the 95% assurance, was developed and is described below.

Sampling Justification for Equipment Acceptance Testing

Objective of Sampling Program: To provide a practical and statistically sound sampling procedure for predicting during in-line modular equipment acceptance testing that the Acceptable Quality Level (AQL) of the process will asymptotically approach the specified AQL of 0.01%.

The AQL and Its Probability of Acceptance

The Acceptable Quality Level (AQL) of a sampling plan is defined in MIL-STD-105D (28 April 1963 p.2) as the "maximum percent defective that, for purposes of sampling inspection, can be considered satisfactory as a process average...Thus, the AQL is a designated value of percent defective that the consumer indicates will be accepted most of the time by the acceptance sampling procedure to be used."

Defect Classification

In accordance with MIL-STD-105D (28 April 1963 p2) a critical defect is defined as a "defect" that judgement and experience indicate is likely to result in hazardous or unsafe conditions for individuals using, maintaining, or depending upon the product...."

Pouches which fail the pouch burst test (Appendix) are classified as critical defects for this program.

Acceptance Number (C) for Critical Defects

The acceptance number (C) of a sampling plan for critical defects is customarily zero. This means that if a sample of pouches drawn from a production lot contains one or more critical defective pouches the decision must be made to reject the production lot because the percent defective in that lot exceeds the AQL.

Cumulative Sample Sizes for Approaching a Desired AQL for Critical Defects

It is assumed when sampling is begun that the process is capable of meeting an AQL of 0.2% (2 failures per 1000 pouches produced). After five production lots are sampled, sufficient evidence will be available to show whether or not the process is asymptotically close to meeting the desired AQL of 0.01% (1 failure per 10,000 pouches produced).

The sample sizes for the conditions described in this memorandum were calculated using factors obtained from Molina's tables*. This sampling system is shown in Table K-II.

Note the sampling cut-off after five lots have been sampled. This cut-off point was selected because it provides a safety factor for quality fluctuations from lot-to-lot even though the Information Index reaches a maximum between the third and fourth lot.

Acceptance Test Stations

Test Station A – Pouch Fabrication and Cut-Off

This is defined as the pouch fabrication and cut-off station and combines modules (1) and (2) of the packaging system (Tasks C and H). Minor deviations from pouch dimension specifications (Task C) while not classified as critical defects should be considered in Task H when making the reliability judgement.

Pouch burst tests are to be made on a minimum of 90 pouches sampled as directed above. Failure of one or more pouches is cause for rejection of the defined unit operation.

Test Station B – Transfer to Pouch Conveyor and Pouch Opening

This is defined as the transfer to pouch conveyor and pouch opening test station. This activity combines modules (3) and (4) of Task C. Only pouches produced in modules (1) and (2) may be employed in testing this defined unit operation.

Pouch burst tests for critical defects are to be performed on a minimum of 90 pouches samples as above. Failure of one or more pouches by this test is cause for rejection of the defined unit operation.

Other qualitative assessments may be made as deemed necessary by Task H in judging the reliability of the defined unit operation.

Test Station C – Pouch Filling, Shaping, Transfer to Carrier and Conveyor

This is defined as the station encompassing pouch filling, pouch shaping, partial sealing if necessary, and transfer to carrier and conveyor. This test station combines modules (5), (6), (7), and (8). Only pouches produced in modules (1), (2), (3), and (4) may be used in testing this defined unit operation.

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*Poisson's Exponential Binomial Limit by E. C. Molina, D. Van Nostrand Company, Inc., Princeton, N.J. (1947)

TABLE K-I

Sampling System for Critical Defects: 0.01% <AQL <0.2%

Lot No.	Acceptance Number (C)	Cumulative Number of Samples	AQL ($P_a = 95\%$)	OQL (1) ($P_a = 10\%$)	$R = \frac{OQL}{AQL}$ (2)
1	0	30	0.173%	7.8%	45.1
2	0	60	0.086%	3.9%	45.3
3	0	90	0.057%	2.6%	45.6
4	0	120	0.043%	1.9%	44.2
5	0	150	0.034%	1.5%	44.1
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
18	0	520	0.010%	0.4%	40.0

(1) OQL = Objectionable Quality Level – the percent defective which will pass undetected one time in ten.

(2) Information Index: Maximum point indicates "optimum" extraction of quality information, i.e., the smallest sample size which adequately discriminates between acceptable and objectionable quality.

Pouch burst tests for critical defects are to be performed on a minimum of 90 pouches, sampled as above, if in the judgement of Task H, any of the machine motions influence pouch integrity. The pouch filling and handling attributes of the unit operation are to be evaluated with foods representative of placeable and pumpable items to be packaged in the production phase. This operation must also be evaluated from its influence on Tasks A, B, and H end item quality requirements.

Test Station D – Pouch Vacuumizing and Sealing

This is defined as the vacuumizing and sealing operation. This is identical with module (9) of Tasks C and H. Only packages produced and handled consecutively in modules (1), (2), (3), (4), (5), (6), (7), and (8) may be used in testing this station. This testing includes foods that are likely to affect the pouch shape which in turn may influence the seal configuration during the sealing operation. According to Task B, vacuumizing will not be required for the bakery items.

Pouch burst tests for critical defects are to be performed on a minimum of 90 pouches sampled as in previous tests. Failure of one or more pouches by this test is cause for rejection of this module. Other qualitative assessments are to be made as deemed necessary by Task H for judging the reliability of this defined operation.

Remaining Modules (10), (11), (12), (13), and (14)

Once tests at the selected stations demonstrate the capability of producing sealed, vacuumized pouches of food free of defects in line with the contract reliability goals, the remaining modules need be given only a qualitative assessment for quality assurance. The retort rack and carriers have already been tested in Tasks C and E and are found to provide proper heat distribution characteristics. Retorting is a known procedure requiring no unusual treatment for the successful heat sterilization of foods in pouches, with the exception of the bakery items.

While it is recognized that the above described modular acceptance testing requirements for predicting reliability are quite demanding, they are the optimal means of generating sufficient statistical data for the precision required in making a probability prediction of reliability. The key to this least cost approach is the system repeatability in producing successive small lots of pouches free of critical defects.

Food Product Acceptance Testing – End Item Requirements

Sampling for end item requirements (Table K-I) shall follow MIL-STD-105D utilizing inspection level S-3 and AQL of 6.5 (normal inspection).

A lot is defined as the pouches of thermoprocessed foods in one retort load comprised of approximately 3000 pouches. At this lot size inspection level S-3 calls for 13 pouches as the sample size, and the AQL of 6.5 accepts the lot if there are no

more than 2 defects in the sample and rejects the lot if there are 3 (accept 2, reject 3).

The required 13 samples may be obtained at "test station C" from the Task H filler acceptance tests. These are to be evaluated against specified end item requirements (Table K-II). Where there is likely to be a variation between samples such as fill weight, meat count, meat weight, vegetable count, etc., individual pouches must be evaluated. Where variation is unlikely because of homogeneity of the mass such as pH, moisture, etc., the 13 pouches may be treated as a batch and a composite made for duplicate analysis. The lot is to be accepted on 2 defects and rejected on 3.

It is preferred that thirteen consecutively filled pouches be selected. The intent is "set-up evaluation" of the filling and sealing operations in order to accept these operations for full production. Thus a form of "pre-control" and process acceptance is achieved faster by consecutive rather than random samples (Juran, Quality Control Handbook, 2nd Edition, pp 25-12 through 25-20, inclusive).

III. Production Quality Control

Start-up of production assumes that the producing line is in the same optimum operating condition as existed during acceptance testing by Task H. The quality control procedure under this condition of continuous operation is one of "auditing" the line. For this purpose 5 consecutively produced pouches shall be withdrawn at the pouch cut-off station at startup and once every 30 minutes of reasonably continuous running thereafter. Pouch burst tests for 3 side seal evaluations are to be performed. Any failure is cause for immediate line shutdown and corrective action.

Additionally, a second set of 6 consecutively produced pouches shall be withdrawn from the line after filling and sealing and before retorting at startup and once every 30 minutes of reasonably continuous running thereafter. Pouch burst tests for top seal evaluation and residual gas measurements are to be performed. Any burst test failures are cause for immediate line shutdown for corrective action.

After retorting and tunnel drying, pouches from production runs shall be removed, visually inspected for workmanship and defects and tested to establish that "end item requirements" (Table K-I), burst strengths and pouch residual gas requirements are met. Twenty-six (2 x 13) pouches randomly selected from each retort load of 3,000 pouches will provide adequate materials for the necessary tests. Sampling will provide adequate materials for the necessary tests. Sampling will follow MIL-STD-105D utilizing inspection level S-3 and an AQL of 6.5 (normal inspection) -- accept 2, reject 3 for sample size of 13 per 3,000 retort load.

Also, after retorting and tunnel drying, an additional sample of 50 pouches will be randomly selected from each retort load, visually inspected for workmanship and defects, then incubated at controlled temperatures to ascertain the commercial sterility of the product and to act as a control for Bio-test samples. Inspection Level S-4 of MIL-STD-105D will be used with an AQL of 1.0 – accept 1, reject 2. Further, to audit commercial sterility prior to incubation, 6 pouches from each retort load will be examined for total viable bacteria per gram and putrefactive anaerobes per gram.

Also, after retorting and tunnel drying, an additional sample of 3 pouches per retort load will be utilized for flavor panel evaluation. Values will be applied to the product by each tester utilizing the nine-point hedonic scale.

All remaining pouches (100%) from production test runs will be inspected visually for workmanship and presence of defects, and then incubated for an appropriate time. The storage samples will be examined for leakers or swells and defective pouches recorded. From accumulated data, the process average will be calculated.

IV. Food Quality Assurance

The packaged food items will be inspected and tested as shown in Table K-III.

V. Thermoprocessing Heat Penetration

The thermal characteristics of the retort and rack systems will be evaluated for each food product using Continental Can Co. thermocouple glands and heat penetration technology. The processes for each product will be established based on the heat penetration data and the specified F_0 value (required lethality) for each food product.

These processes will utilize values and processes previously established by Natick.

VI. Evaluation of Vacuum Leak Test Method for Pouches

Under Task DD, some vacuum leak test trials are reported. Further tests, to conclusively establish whether or not the vacuum leak test is worth using, were carried out under this task.

Various pouches with drilled holes of 1-1.5-mil diameter in the side wall containing steak and vienna sausages were sealed on a MO-VAC sealer under 27" of vacuum for subsequent leak testing after retort sterilization. No leakage (air bubbles) could be detected through the holes when these pouches were tested in a Meade jar under 27" of vacuum.

TABLE K-III

Food Quality Assurance Inspections

In-Process (After Filling, Before Sealing)

1.	Meat Weight	)
2.	Meat Count (1)	) 6 per retort
3.	Total Vegetable	) lot
4.	Individual Vegetable Count (1)	) 1 per 10 minutes
5.	Ingredient Distribution (Bakery items only)	)

Finished Product (After Retorting)

1.	Container Content in Ounces (Net Wt.)	)
2.	Cooked Meat Weight	)
3.	Cooked Meat Count (1)	) 13 per retort
4.	Total Vegetables Weight	) lot
5.	Individual Vegetables Count (1)	) (2)
6.	Ingredient Distribution (Bakery items only)	)
7.	Bread Thickness	)
1.	Residual Gas (1)	)
2.	pH (where applicable)	) 2 per retort
3.	Moisture (Bakery items only)	) lot
4.	Syrup Cut-Out - °BRIX (Pineapple only)	)
1.	Organoleptic Acceptability (Flavor Panel)	) 3 per retort lot

Finished Package (After Retorting, for Sterility)

1.	Visual Inspection	) 50 per lot
2.	Incubation	) (3)
3.	Total Bacterial Count Per Gram	) 6 per retort
4.	Putrefactive Anaerobes Per Gram	) lot

Finished Package (After Retorting, for Defects)

1.	Visual Inspection	) 100%
2.	Incubation	) inspection
3.	Pouch Burst Strength	) 13 samples per lot-3 seals

---

(1) Data to be collected on line for information but not to be used as a basis for sample rejection.)

(2) Based on MIL-STD-105D, which requires 13 samples per lot of 3,000 pouches and for an Inspection Level S-3 and AQL 6.5)

(3) Based on MIL-STD-105D, which requires 50 samples per lot of 3,000 pouches and for an Inspection Level S-4 and AQL 1.0)

Companion pouches with similar holes in the laminate were sealed under atmospheric pressure and leak tested. Again, no air bubbles could be detected when an external vacuum of 27" was applied. These observations gave serious doubts of the validity of any vacuum leak test procedure for detecting defect holes in sealed pouches. The need to have a reasonable explanation led to the experimental work described below.

Continuity of the holes through the laminate was confirmed on representative sample pouches by microscopic inspection and by application of Magnaflux "spot check" dye penetrant.

Pouch sections with equivalent holes were affixed to a cylindrical chamber containing an air inlet (penescope) so that a known differential pressure could be established across the holes by means of a regulated air supply. A soap solution (or distilled water) was spread over the pouch laminate and air pressure was slowly increased until bubbles could be seen leaking through the hole. After leakage had been initiated, the pressure was reduced to determine the minimum differential pressure required to sustain leakage.

With soap solution, a differential pressure of 4 psi was required to initiate the leak, 2 psi to sustain it. With distilled water, the corresponding pressures were 6 and 3 psi, respectively.

A commercially filled pouch, according to the contract specifications, will contain 5 oz. of product fill and not more than 10 std. ml. of air. To calculate the differential pressure when such a pouch is subjected to an external vacuum of 27" in a leak test, it was first necessary to determine the internal pouch volume as a function of differential pressure. This was accomplished by pressurizing a sealed pouch submerged in water through an air capillary and measuring the water displacement. Measurements were made on unrestrained pouches and on pouches restrained by the pouch carrier. The results are tabulated below.

Differential Pressure Inches of Water**	Pouch Volume Restrained in Carrier ml	Pouch Volume Unrestrained ml
5	250	312
10	*	324
15	*	326
20	*	*

* = no further pouch volume increase

** = 1" of H_2O = 0.036 psi

Based on the above pouch volumes and assuming a product fill of 140 ml. (5 oz. density = 1) and 10 std. ml. of air included in the pouch, the differential pressure under vacuum leak test conditions (27" Hg and 20°C.) was calculated. For an unrestrained pouch it is 0.9 psi, for a pouch restrained by the carrier it is 1.4 psi.

Even under the most favorable conditions, a differential pressure of 4 psi is required to detect leakage through a 1-mil. hole. To obtain this differential, 38 std. ml. of air would have to be present in a pouch restrained by the carrier while 62 std. ml. of air would be required in an unrestrained pouch. Since air volumes of this magnitude cannot reasonably be expected in a commercially filled pouch, vacuum leak testing does not appear to be feasible for products other than bakery.

APPENDIX

TEST METHODS

The following section describes in detail the major test methods (Task K) to be used in the quality assurance portion of this program. The test methods described are:

TEST METHODS

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Name:	Bond Strength Determination
Purpose:	The purpose of this test is to determine the bond strength or resistance to separation of one flexible ply from another when bonded together by an adhesive and where the adhesive is the inner member ply.

Equipment:

1. Scott Tester, Model X-5 (Henry L. Scott Co., Providence, R.I.).

   or

2. Suter Tester (Alfred Suter, Textile Engineer, 200 Fifth Avenue, N.Y.).

   or

3. Any other mechanically operated device as a suitable means of holding this specimen at a uniform rate of pull and means of recording the resulting strength values.

Description: These are mechanically actuated machines in which the bond of the specimen is stressed by a uniform movement of the pulling clamp to which one end of the specimen is attached, the other end being held in a clamp attached to a weighing device based on the principle of the pendulum. The rate of pull is 12 inches per minute. The pendulum device automatically registers the pull in grams required to separate the plies on a calibrated scale.

1. Capacity: The equipment has various means for changing the total loading, or larger size testers may be used providing the loading is kept to at least 25% of the maximum measurable load. One-inch specimens should be used whenever possible, but it is permissible to use 1/2"-wide specimens to come within the loaded range of the max. Under no circumstances shall specimens be less than 1/2" wide. In every case, the results shall be calibrated and reported in terms of one inch of width of bond.

2. Calibration and Adjustment: Before each bond test is made, the pendulum device must be set at zero to give proper readings. The testers must be calibrated once a month in the following manner:

   Level the machine accurately in both directions and clear the mechanism to insure that it moves freely. Apply various dead loads to the clamp actuating the indicating mechanism and note

the scale readings when the load and mechanism come gently into an equilibrium position. This can be conveniently done with the pendulum-type of tester by wedging up the pawls holding the pendulum with a small piece of paper bent double, suspending the test weights to the upper clamp and allowing the pendulum to come to equilibrium from the direction in which it moves when the load is applied to it. The lower jaw should not be used for supporting the test weights during calibration. Make a record of deviations from the indicated readings and apply corresponding corrections to the test results.

Test Samples:

A. The test sample shall be representative of the material being tested.

B. Five samples cut an inch wide taken from the longitudinal or machine direction of the material being tested shall be tested.

C. The test samples shall be 5" in length.

D. The utmost care shall be exercised in cutting strip samples to prevent nicks and tears in the edges which might give rise to premature tears. The edges shall be parallel to within 2% of the width.

Conditioning:

All test samples shall be tested at Standard Room Temperature. Standard Room Temperature is defined as an atmosphere of unspecified relative humidity at a temperature in the range of 20 to 30°C. (68 to 86°F.)

Procedure:

A. The plies of the test sample are separated slightly by the action of an active solvent or by the application of heat.

B. The free ends are then placed and anchored in the two clamps, taking care that the sample is lined up parallel to the clamp.

C. The "tail" (or the end of the sample to be tested) should be placed in the jaws so that it is next to the person doing the test. Both plies must be separated from the "tail" at a 90° angle

D. After the loose ends are secured in the jaws, release the holding lever to start the test.

E. Observe the reading on the scale. If the reading goes beyond the limits of the scale, an additional weight must be attached to the pendulum.

Calculations: A. Record the bond strength as grams per linear inch.

B. Results of the 5 strip tests shall not vary more than 5% from the average.

C. If the bond strength of the 5 samples vary more than 5% from the average, another 5 samples shall be taken for test.

Remarks: Some light gauge materials are supported by tape in the clamping jaws to prevent tearing or slipping.

Reference: TAPPI, Testing Methods, Recommended Practices, Specifications, T-404-M-41.

Name: Seal Strength

Purpose: To determine the seal strength of heat sealable materials.

Equipment:

1. Wrap-ade sealer with flat metal chrome plated jaws (both heated) Model No. BO, set for 1/2-second dwell time, or Packaging Industries, Ltd. Sentinel sealer with variable dwell temperature and pressure.

2. Standard Alfred Suter Tensile Tester, or equivalent, cross-head speed of 12 inches per minute.

3. Laboratory hand laminator or draw down equipment.

Procedure:

1. Cut test sample into 5" width, approximately 2-1/2" long.

2. Seal test samples together in the face-to-face structure with the heat sealing agent as the interface or sealing surface. Use type of sealer, dwell time, temperature, or pressure as specified. See Remarks, par. 3, page 214.

3. Cool the sealed sample (between two cool metal plates) to room temperature and cut exactly into 1" widths.

4. Insert the test sample into the jaws of the tensile tester so that one tongue of the test sample is in the upper jaw and the other is in the lower jaw with the sealed portion away from the operator placed downward.

5. Operate the appropriate controls on the tensile tester to determine the seal strength of each strip.

Results:

1. Report results in grams/inch of width (usually the average of five individual strips). Include type of sealer, temperature, dwell time and pressure where applicable.

2. Indicate the optimum seal temperature for the test sample.

Remarks:

1. For materials which are heat sealable on both sides, use 50-gauge Mylar "C" as slip sheet to sandwich between jaws of sealer.

2. Use of Sentinel Sealer implies only top jaw heated. The top jaw is teflon coated, and the bottom backing consists of 1/4"-thick silicon rubber covered with a sheet of teflon coated glass cloth.

Name: Pouch Curst Strength

Purpose: To determine seal failure on liquid and cook-in type pouch structures.

Equipment & Material

1. Equipment arrangement shown in Figure 1.
2. Machine or hand fabricated pouch samples.

Procedure:

1. Adjust pressure gauge to 40 psi (unless otherwise indicated).
2. Insert pouch lips around the air outlet and between the rubber covered jaws.
3. Clamp jaws tight on lips of pouch.
4. Release vaive letting air into pouch gradually to come to 40 psi (or other established pressure) in 30 seconds and hold for 30 seconds. Observe for bursting and record time if a burst occurs.
5. Close valve and remove pouch.
6. If pouch does not burst, examine it for partial seal failure (defined as an irregular seal separation). If partial seal failure (seal yield of 1/16" permitted) is noted, insert pouch again into the testing apparatus and check for an additional minute.

Results: Report pouch burst failures and partial seal failures and give their approximate locations. Also report the time for burst or failure.

3. To determine seal range, standard procedure is to use Sentinel sealer, 40 psi., 1/2-second dwell, and temperature in increments of 25°F. from the lowest seal temperature to maximum temperature at which heat resistance of test materials is satisfactory.

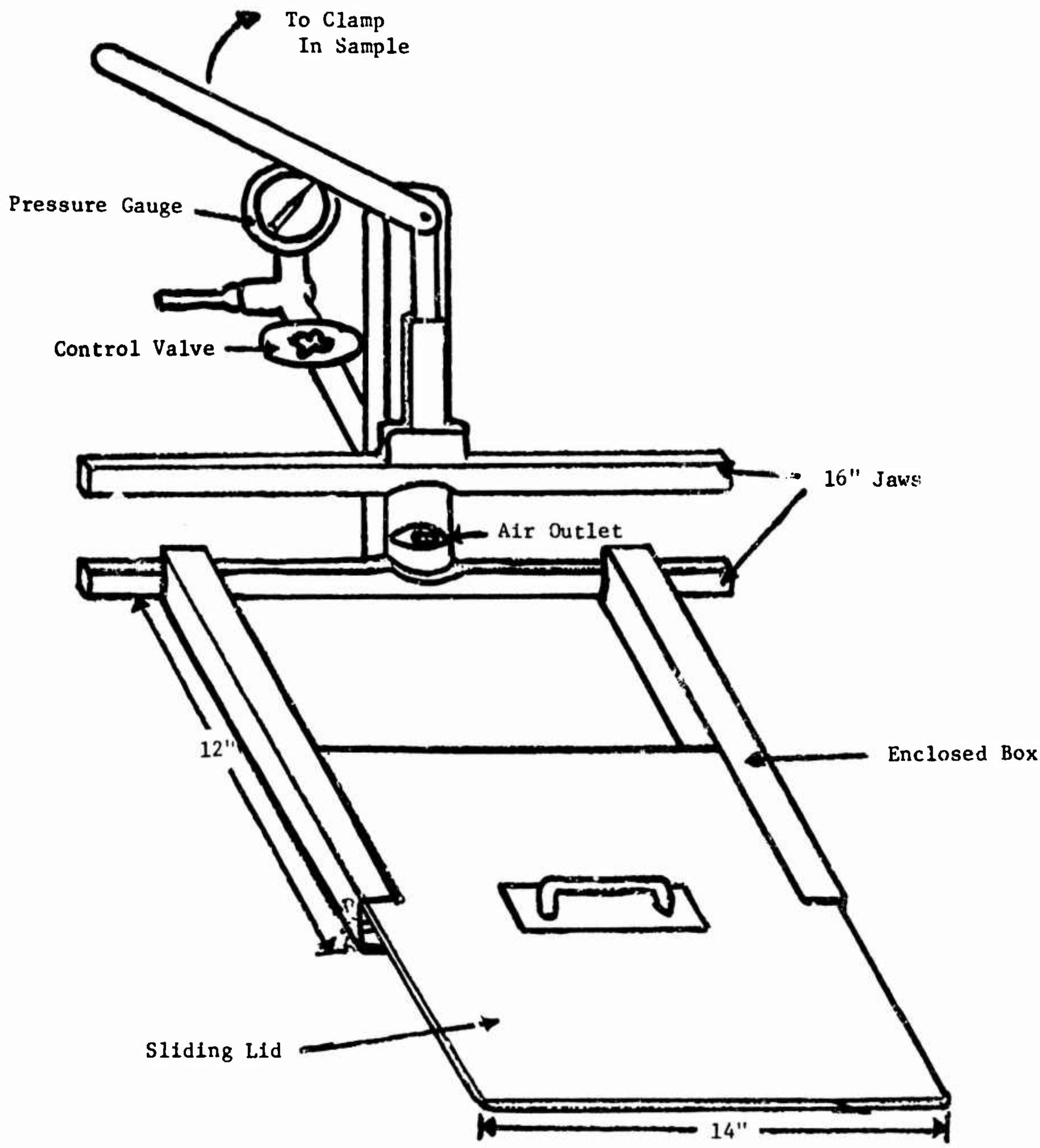

Figure Appendix 1. Burst Test Apparatus

Name: Odor Test

Purpose: To determine the presence of any objectionable odor (See Note on page 217) in a packaging material, and further, its level on a scale of 1 (excessive) to 10 (essentially none).

Apparatus:

A. Wide-mouthed one-pint Mason jar and screw cap with any liner removed.

B. Aluminum foil (approximately .0005").

C. Convection oven.

Procedure:

1. A. Deodorize bottles by washing thoroughly with perfume free detergent and odor free water and then rinsing with odor free water.

   B. Same procedure for "de-odorization" of the foil.

2. Dry bottles thoroughly at elevated 200°F. temperature for 30 minutes in an odor free oven.

3. Place sample in Mason jar and attempt to maintain as much air-surface contact as possible. (Rolling into a loosely wound tube is helpful.) Avoid aeration of the sample by placing it in the bottle immediately after it is secured from the parent quantity.

4. Place foil on jar and screw on cap.

5. Place jar in oven at 110°F. for 30 minutes.

6. Remove jar from oven and cool to room temperature.

7. Remove jar top and puncture foil. Smell enclosed air immediately. The first observation of the tester is most reliable as the odor will usually dissipate rapidly. Replication is helpful if any doubts exist, but not essential for test accuracy.

Results: Rate odor or absence of odor.

A. Numerically:

10 – essentially no odor
9 or 8 – slight odor but not objectionable
7 – noticeable odor - borderline
6 – 3 – appreciable odor - objectionable
3 – 1 – excessive - objectionable

B. Brief subjective comment and/or description of odor type source.

Test Samples: Samples from roll stock shall be cut out after removal of the three outer turns of the roll. Sample size shall be 144 sq. in. ± 10%. If necessary, cut sample into strips to facilitate insertion into the jar. Sufficient quantity shall be obtained to allow each panel member an individual sample (144 sq. in.). Samples are to be coded with nonconsecutive three-digit numbers to avoid such code systems as a, b, c or No. 1, No. 2, No. 3, which might contribute to prejudicial evaluation based on the numerical order.

Test Panel: The panel shall consist of a test director and no less than four members. They shall be selected on a basis of demonstrated ability to discern odors relative to packaging products; i.e., resins, waxes, solvents, inks, synthetic films. It is preferred that the panel is trained to also determine the type and/or source of these odors.

Care must be exercised to avoid exposure of personnel to solvents or like materials on a daily basis. This obviously would tend to diminish the acuteness of their sense of smell.

Test Area: The actual test area shall be free of "external" odors such as cigarette smoke, plant odors, and the like. A small, thoroughly air-conditioned room is the ideal area. Avoid the presence of any distracting influences.

Standard Samples: Whenever possible, each panel member shall be informed, by the use of representative samples, as to acceptable and/or unacceptable odor levels specific to a customer or an industry. This may be done prior to, or at the time of the actual test. (This is an integral part of the training of an odor test panel.)

Comments:

1. If at all possible, tests should be conducted individually by the panel members, rather than in a group.

2. After the test is completed, panel members should discuss their individual findings. It is important that the test panel members realize they are determining the suitability of a product for a given end use, not the product *per se*. This will assist in avoiding purely subjective results.

3. A blank should be included in each series of tests to insure odor free test containers.

Note: It is possible that an odor may be present in a product to any varying degree and yet not be objectionable. This must be determined on an individual basis between customer and supplier.

Reference: National Flexible Packaging Association Odor Test.

Name: Aerograph "Carbon Count" Determiniation

Purpose: An electronic method of determining the presence of objectionable "carbons" in packaging materials and its comparison in parts per million with standards.

Equipment:

1. A modified Model 600 D Varian – Aerograph Gas Chromatograph wherein the packed chromatographic column has been replaced with a short length of unpacked capillary tubing.

2. Strip-Chart Recorder Varian Model G11A.

3. Mason jars with lids equipped with Swadgelok Sampling Ports (Figure Appendix 2).

4. Hamilton No. 701N 10 Micro-Liter Syringe(s) for standard preparations.

5. Hamilton No. 1750 0.5 ml. gas-tight syringe(s) for sample injection, equipped with Hamilton No. N-725 Point Style No. 1 25 gauge x 2" Luer-Lok needles (replaceable).

6. Cylinder of Prepurified Nitrogen and Regulator Matheson CGA Model 8 No. 580 or equivalent.

7. Cylinder of Prepurified Hydrogen and Regulator Matheson CGA Model 8 No. 590 or equivalent.

8. Cylinder of Prepurified Compressed Air and Regulator Matheson CGA Model 8 No. 350 or equivalent.

Procedure:

A. Instrument Startup and Checkout: The efficient and correct operation of the instrument depends on the understanding of how each control and connector functions and their proper use in operating the instrument. Therefore, it is recommended that all instructions be read and carefully followed. Operating parameters are: oven temperature – approximately 50°C; injector control setting – "zero".

B. Sample and Standards Preparation:

Introduction: Samples and standards are prepared in 1-qt. Mason jars which are equipped with lids which have special sampling ports. The sampling port is a Swadgelok fitting which has been

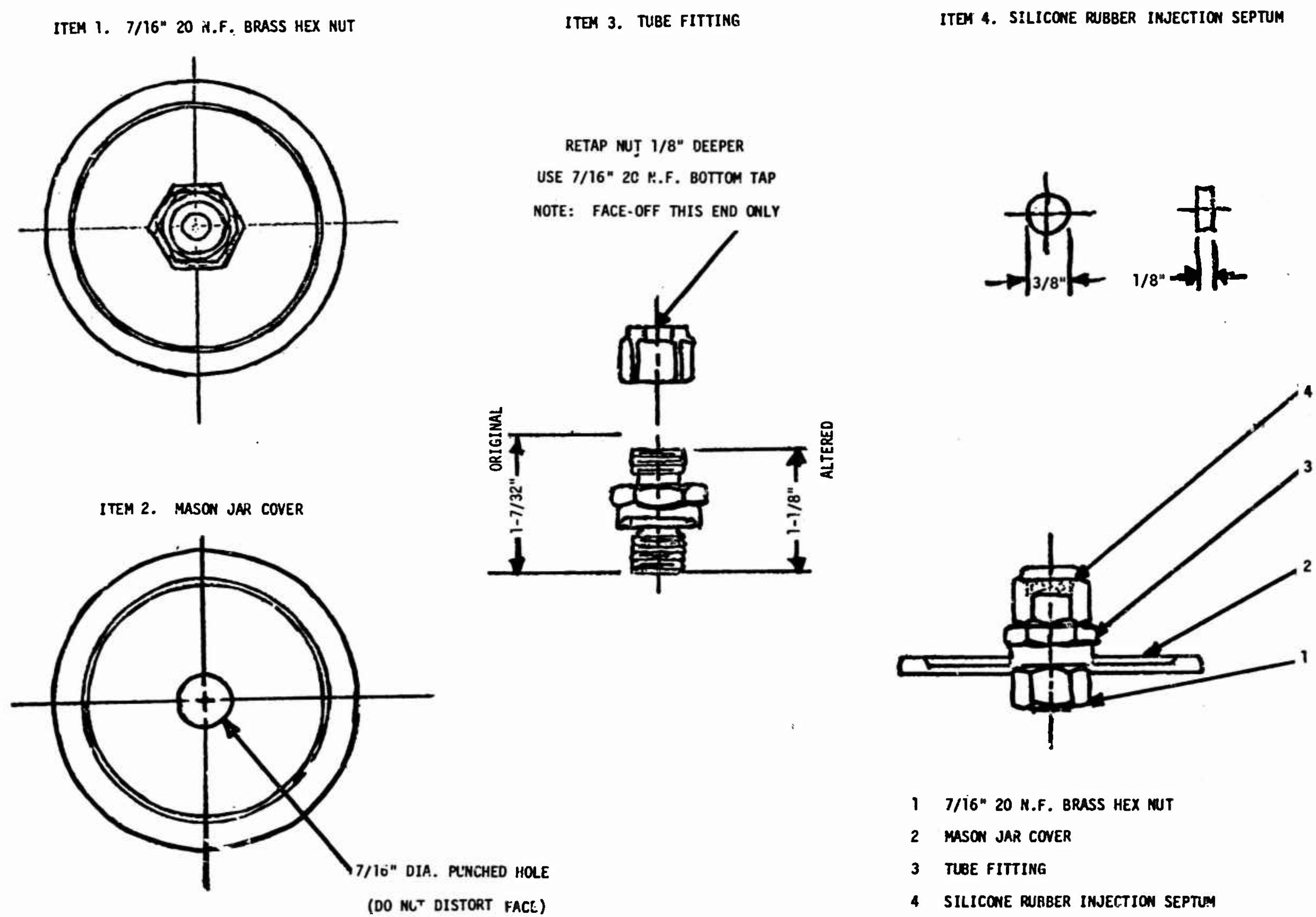

FIGURE APPENDIX 2. HYDRO-CARBON SAMPLING PORTS.

modified in such a manner that it will contain a silicone rubber septum and provide a leak-tight seal. The sampling port allows the withdrawal of a given volume of sample gas by means of a Hamilton gas-tight syringe. This procedure allows the same sample to be analyzed by the instrument and subsequently tested by an odor-testing panel if necessary.

Sample Preparation:

1. Place 1 sq. ft. of sample film in a 1-pint jar which has been purged with clean, dry air or nitrogen.

2. Cover the jar with the required lid-sampling port sampling.

3. Place jars in an oven at 120°F. for 1/2 hour.

4. Remove and allow to cool to room temperature.

Working Standards:

A working standard for a "go-no-go" quality control procedure is prepared from information gained previously by organoleptic tests, and its concentration is that which corresponds to the maximum allowable hydrocarbon concentration.

1. Purge a 1-qt. jar with dry, uncontaminated air or nitrogen and close with the required type of lid.

2. Inject through the septum 1 microliter of toluol for each ppm concentration desired.

3. Place the jar in an oven at 120°F.; keep for 30 minutes and then remove and allow to cool to room temperature.

C. Analyzing Sample:

After instrument startup the sample is analyzed as follows:

1. Place RANGE switch on 10 and attenuator switch on 2.

2. Inject 0.30 ml of the working standard into the injection port of the instrument, and observe the trace of the recorder pen.

3. Adjust the attenuator switch and sample volume of subsequent injections (not below 0.20 ml.) until recorder pen deflection is about 1/2 full-scale of recorder.

4. Make three injections of the working standard.

5. Make three injections of the sample.

6. Measure the peak heights of the traces and calculate average peak heights for the sample and for the standard.

7. If relevant, the approximate concentration of the sample can be calculated from the following formula:

$$\text{Concentration Sample (Approx.)} = \frac{\text{peak Ht. Sample X Concentration Standard}}{\text{peak Ht. Standard}}$$

Notes:

1. An effort must be made to make all injections at the same speed.

2. Occasionally, a needle becomes clogged with minute pieces of septum rubber and must be cleaned with a fine wire or changed.

   Clogging is evidenced by drastic changes in peak heights of consecutive injections.

3. A working standard should be discarded after 10 ml. has been withdrawn.

Retortability of Laminate

Subject appropriate size sample (at least 4-3/4 x 7-1/4") of specified laminate to a steam atmosphere at 250°F. and 22 psig pressure for 30 minutes. The required 22 psig comprised of 15 lbs. steam pressure plus 7 lbs. of overriding air pressure - simulates processing conditions.

Sample after this environmental testing shall show no delamination or evidence of seal deformation.

Name: Headspace Gas Volume Determination in a Flexible Pouch

Purpose: To measure the volume of gas headspace in a flexible pouch by displacing water in a graduated cylinder or gas measuring burette. (See Figure Appendix 3, page 225).

Equipment:

1. Graduate, or gas measuring tube, size would depend on pouch to be tested.
2. Funnel.
3. Deep sink or water bath.

Procedure:

1. Fill sink or water bath with water.
2. Insert funnel into graduate and submerse under water.
3. Invert graduate so that bottom is above water. The graduate should be free of any air. If using a sink, be certain the drain plug is secure so as not to let any air gain entrance.
4. Take pouch to be tested and notch the seal area to insure easy opening.
5. Submerge the pouch in the water under the funnel and tear open.
6. The water in the graduate will be displaced by the gas in the pouch and the total volume of gas headspace in the pouch can be easily read on the calibrated graduate.

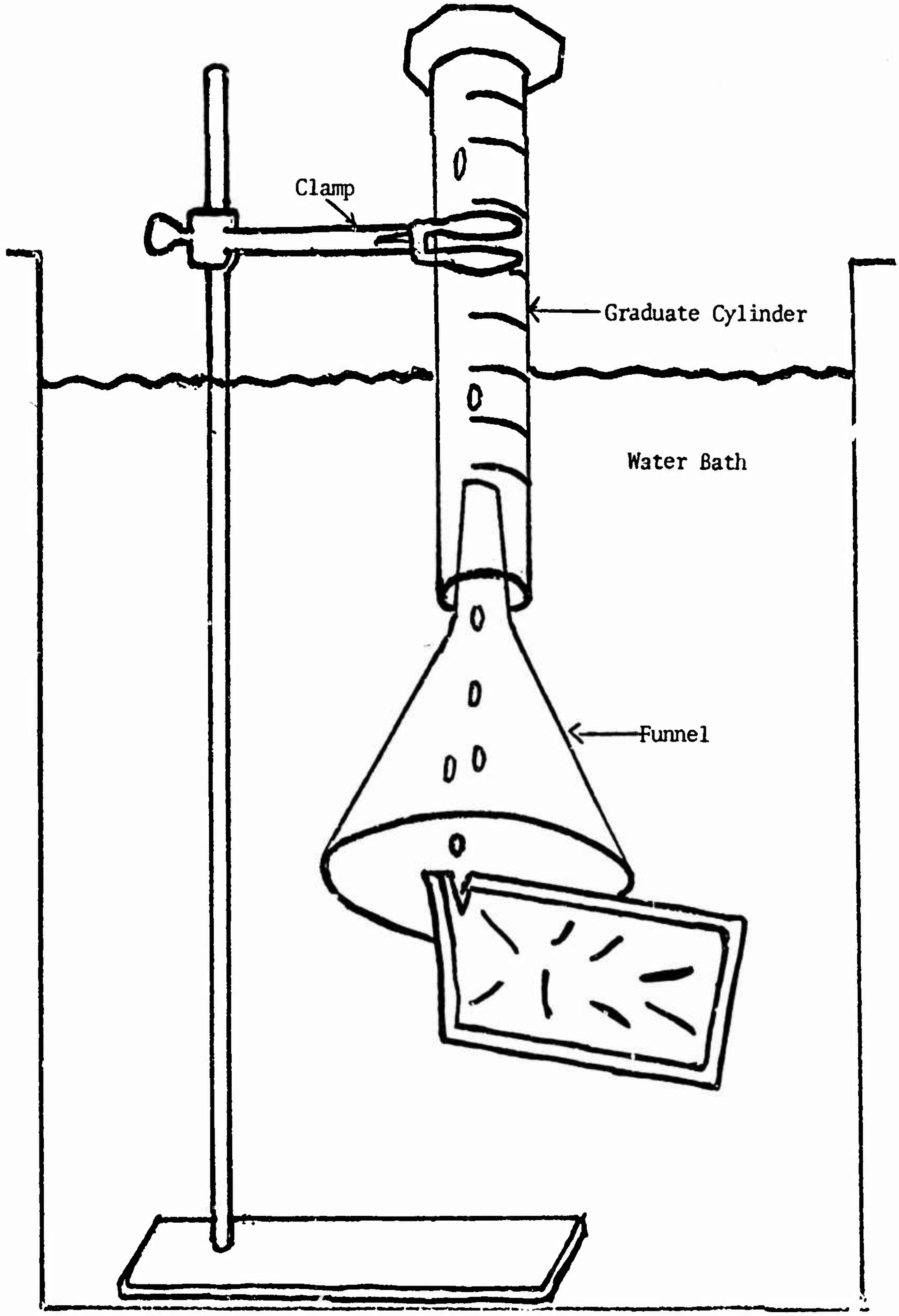

FIGURE APPENDIX 3. HEADSPACE GAS VOLUME DETERMINATION IN POUCH.

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GLOSSARY OF TERMS AND ABBREVIATIONS

Acceptable Quality Level
: The maximum percent defective that, for the purposes of sampling inspection, can be considered satisfactory as a process average.

Acceptance Sampling
: A quality control sampling plan designed to provide a statistically sound, workable sample size, an acceptance number, and a rejection number so that satisfactory lots of material can be accepted and unsatisfactory lots rejected with reasonable assurance. Acceptance sampling plans are formulated on the mathematical laws of chance.

Air Cylinder Pressure
: Supply pressure acting on the air cylinders. Dimension: psig.

Air Cylinder Force
: The force exerted by the piston of an air cylinder can be calculated by multiplying the air cylinder pressure by the effective piston area. Dimension: lbs. Note: In some installations, more than one air cylinder per bar is used. This has to be taken into account in calculating the clamping force.

Air Jet Splitter Blade
: Extension of swinging splitter blade – ported on under side to permit air pressure to enter pouch.

Air Jet-Squeezer Mechanism
: Device for sealing off top edges of pouch on air jet splitter blade to permit air pressure build-up in pouch.

Allowance
: This term, as applied to the fitting of machine parts, means a difference in dimensions prescribed in order to secure classes of fits.

Angular Velocity
: The angular velocity of a rotating body is expressed in angular measurements and equals the angle through which any radius of the body turns in one second. Generally expressed in radians.

Anvil Bar
: That part of the pouch sealing mechanism against which the sealer bar strikes during sealing. The bar sealing surface is usually covered with rubber, and the anvil bar may be heated or left at room temperature.

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Anvil Rubber

(See Sealing Rubber.)

Backlash

The lost motion between two machine parts which transmit motion one to the other is often called backlash.

Bag

Pouch.

Bag Clamp

Device for holding individual pouches in position on bag clamp conveyor.

Bag Clamp Conveyor

Conveyor chain with bag clamps attached at equal intervals or pitches.

Bagmaker

The portion of the packager that produces the pouch (web forming and sealing section).

Bellcrank

A bent level having two arms at an angle to each other and pivoted at the point where the two arms join.

Bevel Gear

Bevel gearing is used for transmitting motion between two shafts located at an angle to each other and normally having center lines which intersect or lie in the same plane.

Blow-Down

(1) Reduction of steam pressure in retort to nil after the process period and introduction of cold water with over-riding air pressure until achieving a predetermined reduced product temperature (also called "chilling" or "cooling").

(2) The procedure of draining the water from a retort after chilling. (This terminology is used in Task EE.)

Bottom Cooling Bar

Ambient or liquid cooled bar to chill bottom seal.

Bottom Seal Bar

Heated bar that produces bottom seal. Also known as anvil bar.

Bottom Seal Mechanism

Mechanical rocker assembly to move horizontal bottom seal bars in contact with web.

Carrier

Container that filled pouch is inserted in and used for transporting the pouch through vacuumizing and heat sealing and retorting.

Chain Guide

Guide or track to support chain.

Check Valves

Designed to allow any fluid to pass through them in one direction only, any pressure in an opposite direction tending to close the valve.

Clamping Force

(1) Total

Total force acting during sealing between the anvil bar and the sealer bar. May be calculated from the air supply pressure and the effective area of the air cylinders in air actuated systems or from the spring constant and the compression length when the clamping system is spring loaded. Dimension: lbs.

(2) Per Linear Inch of Contact between Sealer Bar and Anvil Bar

Total clamping force divided by the length of the pouch being sealed. Strictly applicable only when both bars have a hard surface (no rubber). Dimension: lbs./in.

Code Number

(1) A number assigned to a standardized material, or

(2) A number assigned to packaged product to identify date of manufacture and type of product.

Coding

The practice of embossing a code number or marking on the package.

Come-Up Time

(1) Come-up time pertains to the time required for a retort process temperature to reach the desired product process temperature after turning on the steam to the retort.

(2) Time for a heated part to reach the set point temperature. Dimension: minutes.

Commercial Production Guides
Final accepted "guideline formulations" for food items which are to be followed during production.

Commercial Sterility
That degree of sterility at which all pathogenic and toxin producing organisms have been destroyed as well as other more resistant types which, if present, could grow in the product and produce spoilage under normal storage condition.

Control Limit
A quality control term used to describe the upper and lower limits within which a process or machine may operate with change variation alone. Sample values exceeding these limits are out of control due to an assignable cause. Control limits are calculated using factors based on sample size. Control limits are not necessarily the specification limits since specification limits (tolerance limits) refer only to individual items while control limits refer to charts for averages, ranges and so forth.

Control System
That system using electrical, electronic, pneumatic and mechanical devices which govern the conditions, including temperature, pressure, water volume, etc.

Creaser Rod
Square rods to crease web at plow nose.

Dancer Roller
Spring loaded, vertically moving roller used for tension control.

Distribution
A statistical and quality control item. An arrangement which shows the frequency of occurrence of a series of measurements. Common types of distributions are the normal or even distribution (bell curve) and the skewed or uneven distributions with most of the measurements falling toward one side of the distribution.

Dolly
Caster-wheeled carts used to transport the retort cars outside the retort.

Durometer
A scale for expressing the hardness of rubber and plastics by measuring the penetration depth of a standard indentor under a standard load. The measurement is made according to ASTM D 224064T. The minimum rubber thickness required for testing is 1/4 in. and unless specified otherwise, the reading is taken one second after contact. For sealing rubbers, the Shore A scale is appropriate.

Dwell Time

Time period during which the sealer bar in hot bar sealing remains in contact with the anvil bar. Dimension: seconds.

Equilibrium Temperature

Temperature at which heat loss is balanced by heat input. Dimension: °F.

Equipment Capability

Refers to a statistical study of a machine to determine its ability to manufacture containers or container parts to dimensional or to other quality standards. Such a study determines the natural or normal variation to be expected in continuous operation and allows for a realistic choice of tolerances for a given set of specifications.

Equipment Setup

Refers to systemized means of setting up a machine to produce containers or container parts to quality specifications. An equipment setup involves a predetermined sampling, measuring, and interpretation plan. The end result is that when the machine is placed in production the quality level of the product is assured to be at the quality level specified.

Feed Roll and Cut-Off Assembly

Mechanism for advancing web past cut-off knife into bag clamp and cutting web to produce pouch of proper width.

Filler

Device to supply product to filling nozzles.

Filling Nozzle

Device for dispensing product in pouch.

Flowable Foods

Any food mixture or formulated item which is liquid or semi-solid in nature and may be handled through either a pump-type, volumetric-type or gravity-type filler to put it into the flexible pouch. Examples: Beef Stew, Beans in Tomato Sauce, etc. (This group was originally referred to as "pumpable foods".)

F_o

Sterility value, pertaining to the process applied to a food item to achieve a desired microbiological sterility and measured as a numerical value of 1.0 assigned to each minute at 250°F. or the appropriate fraction thereof.

Franks

A cooked, formed, appropriately spiced meat link; also called "frankfurters" or "weiners".

Fusion
The process of joining two surfaces by heating them just beyond their melting points and achieving bonding of the two surfaces.

Fusion Temperature
Temperature at which the polymeric inside interfaces of a pouch will bond together under prescribed time and pressure. Dimension: °F.

Gas Analysis
Refers to the laboratory analysis of gases contained in the headspace of a sealed container. Usually includes the determination of oxygen, hydrogen, carbon dioxide, and nitrogen. Assists in determining cause of can end swelling, spoilage (carbon dioxide), corrosion (hydrogen).

Guideline Formulations (or Formulas)
Original Natick or revised Swift or Pillsbury product formula, handling, processing, and end product specifications and guides which are still subject to revision.

Heat Creep or Heat Bleed
Penetration of heat from the seal area of the pouch beyond the limits of the sealer bar geometry resulting in a seal which is not clearly defined and gives rise to stress concentrations.

Heat Penetration Curve
A curve showing the time-temperature relation at a point within a product during the heating and cooling phases of a process and which can be reproduced from specified thermal characteristics.

Hold Time
Time period during which the sealer bar is held against the anvil bar after the heating pulse in impulse sealing. Dimension: seconds.

Hot Bar Sealing
Pouch sealing with a continuously heated sealer bar.

Impulse Sealing
Pouch sealing with a short pulse of intense heat, usually by a resistance wire ribbon.

Impulse Time
Time during which energy is applied in impulse sealing. Dimension: seconds.

In Control
A quality control term meaning that the sample values (such as averages and ranges) fall within the control chart limits. The variation of the points within the limits is due to nonassignable causes and the process or machine is considered to be operating in a normal manner.

Incubation Period

A period of time at temperatures favorable to bacterial growth, corrosive action, or chemical decomposition.

Inherent Variation

Indicates variations in a machine or process performance which are due to the natural operating conditions of the machine or process, such as worn parts, gear play, difference in incoming materials, etc. It is "inherent" variation because it is the final variation associated with the machine or process after all assignable causes have been remedied.

Initial Temperature (I.T.)

Average temperature of the contents of the coldest package or can in a retort charge at the time steam is turned on for the process.

Inoculated Pack

An experimental lot of packaged food to which has been added a known quantity of bacterial culture for purposes of determining the effect of a given sterilizing process or heat treatment.

Inoculated Test Pack

Biological method of evaluating the sterilizing efficiency (F_0) of a process, based on inoculation of the product in question with spores of a significant organism having predetermined thermal resistance characteristics, followed by testing the processed containers, after incubation, for surviving inoculated organism.

Laminate

To build up by means of combining thin sheets.

Markers

Units installed on machines to apply a distinguishing mark to a container.

Mechanical Timing

Timing of a machine by which operations are started in synchronization with moving parts.

No Pouch No Fill

Photo-cell detector to lock out filler when no pouch is present.

Notcher Assembly

Mechanism that produces notch at side edge of pouch for easy opening.

On-Off Controller
Power is switched on and off as temperature passes the set point.

Over-and-Under Shoot
Temperature excursions above and below the set point. Dimension: °F.

Overfill
More than required amount of product in the pouch.

Overriding Pressure
Air pressure added during retorting to the steam pressure to prevent pouches from bursting. Dimension: psi.

Overwrap
A kraftboard envelope-type folder applied over a flexible package for protection during distribution.

Pack
To fill a package in a food processing line or the complete run of one product.

Packager
The entire form, fill, and seal machine.

Packaging Appraisal
Evaluation of an experimental container or material under commercial customer packaging conditions.

Parameter
A value, such as the average of a universe, that describes some characteristic of its distribution.

Pass
A single trip through a machine, changing an article from one condition to another.

Phase
(1) A portion of the overall contracted program prior to major review point.

(2) The number of different deliveries of voltage or current available in an alternating source is designated as the number of phases available.

Pinhole
A minute hole through packaging material caused by manufacturing defects in the material or subsequent material mishandling.

Placeable Foods

Food items of a completely solid nature and occurring as a whole piece prior to and after filling and must be positioned into the pouch by manual handling. Examples: beef steaks, beef slices, franks, etc.

Plow

Triangular shaped plate used to fold web into basic form.

Plow Nose

Replaceable point of plow.

Pouch Former

Device to shape inside of pouch prior to filling operations.

Pouch Volume

Volume enclosed by a sealed pouch. Dimension: ml or fl. oz.

Preload

Mechanical restraint applied to a compression spring causing it to exert a minimum force. Dimension: lbs.

Presetting Starches

Heat treating of solubilized starchy materials to approximately 170° to 180°F. in sauces and gravies to thicken or swell the starch granules and prevent separation during filling operations and retorting processes.

Pressure Cooling

Maintenance of pressure on processed cans in a retort by means of steam, air, water or combination thereof, during partial water cooling.

Pressure Differential

Difference in pressure between two sides of a common barrier. Dimension: psid.

Process

Designates the heat treatment or "cook" given a product after the container is permanently sealed, in terms of the time and temperature required to produce commercial sterility under normal conditions of contamination.

Proportional Band

Percentage of scale range over which a proportional controller applies proportioning action.

Proportioning Temperature Controller
Applies power in proportion to temperature difference between actual temperature and set point.

Protein Coagulation
Heat treating of meat products to set or denature proteins to the extent of preventing soluble proteins, commonly referred to as coagulated meat juices, from separating from the meat during retorting.

Pyrometer
A temperature measuring device whose action results from the effect of temperature upon the electrical properties of its circuit.

R.T.
Retort temperature.

Rails
Structure within the retort which supports the retort cars.

Register
To have one part positioned accurately with regard to another.

Rejectable Items
Manufactured items which, through use of improper materials or faulty manufacture, cannot be used for intended purpose.

Retort
A horizontal cylindrical vessel used to cook various products in water under pressure.

Retort Body
The cylindrical portion of the retort which contains the retort cars.

Retort Cars
Wheeled carts used to support the racks containing pouch carriers within the retort.

Retort Rack
Unit that carriers are put in, prior to retorting.

Right Hand Side
The side of a product or machine on the right hand side when looking in direction of travel of product through machine.

Roll of Web
Roll of flexible material used to produce pouches.

Run

A term used to express the time interval or act of manufacturing a trial or contract order of a given package size to a given specification.

Running Check

An inspection or control check made while machine is operating.

Sealer Bar

That part of the pouch sealing mechanism which provides the heat to effect the seal.

Seal Contamination

Foreign matter in the seal area may be water, grease or other material. Type of material, how applied, quantity, etc., have to be specified in order to be meaningful.

Sealing Curtain

Glass cloth covering of the anvil or sealer bar to protect the pouch.

Sealing Pressure

Total clamping force divided by the seal area. Strictly applicable only when both bars have a hard and flat surface (no rubber). Dimension: lbs./sq. in.

Sealing Rubber or Anvil Rubber

Facing material on the anvil bar.

Separator

A simple paperboard sheet, or a wood or metal tray used to separate tiers within a container or in a pallet load.

Service Life

The period of time a product or material will resist change or deterioration under a given set of storage conditions.

Shear

To cut. Irregularity of cutting surface by which a cut is progressive so that all parts of the cutting surface do not start to cut at the same time.

Shelf Life

With canned goods, refers to the length of time the container and/or product will remain in a satisfactory condition under normal conditions or retail storage.

Side Cooling Bar

Ambient or liquid cooled bar to chill side seal.

Side Seal Bar
Heater or cool bar that produces side seal.

Side Seal Mechanism
Mechanical rocker assembly to move vertical side seal bars in contact with web.

Sloppy Joe
A ground meat in a spicy tomato sauce product – also called "ground beef with pickle flavored sauce".

Solvent
Also called a thinner. Any liquid capable of dissolving a solid substance to form a solids free solution. For example, water, alcohol, naphtha, etc., used in enamels, lacquer, sealing compound, fluxes, etc.

Spalling
The cracking and flaking of metal particles from a surface.

Specification Limits
The boundaries or extremes of a specification. The amount of variation allowed produced items.

Specifications
The rules which govern the manufacture of items. A statement of the dimensions or visible characteristics which every produced item must meet to be acceptable quality.

Splice
The end joint uniting two webs.

Splitter Blade
Blade for guiding top edge of pouch.

Spoilage (Canned Foods)
Any condition resulting from physical, chemical, or bacteriological action to the container or its contents which renders the item commercially not merchantable.

Spring Constant
Force exerted by a spring per unit compression or extension. Dimension: lbs./in.

Standard of Fill
The official fill for food containers as required by the Food and Drug Administration for various sized containers and products.

Steam Distribution
: Distribution of pure steam (free of air) throughout the retort charge during the come-up and process periods.

Steam Spreader
: Perforated extension of steam inlet inside the retort to permit even distribution of entering steam.

Stuffer, CP-St. Regis
: Filling device manufactured by CP Division of St. Regis.

Stress
: The load per unit of area. Ordinarily stress-strain curves do not show the true stress (load divided by area at the moment) but a fictitious value obtained by using always the original area.

Surface Temperature
: Temperature measured at the surface of the heated bar with a surface pyrometer. Dimension: °F.

Swinging Splitter Blade
: A section of splitter blade that swings out of the way of the knife blade to permit pouch cut-off.

Teflon Apron or Curtain
: Teflon coated fiberglass cloth used between web material and seal bar.

Temperature Controller
: Electrical device for regulating the temperature of a heated bar.

a) Variable Transformer – Manual
b) On-Off Controller -- Automatic
c) Proportional Controller – Automatic, power proportioned as required.

Temperature Gradient
: Temperature differential across a surface or through a cross section. Dimension: °F.

Temperature Set Point
: Temperature at which the heater is maintaining the control thermocouple. Dimension: °F.

Test Pattern

Shall specify in which manner T-peel specimens are taken from the pouch. Define left and right by viewing the pouch either from the sealer bar or the anvil bar side or in relationship to the leading and trailing edge of the pouch traveling through a machine. No standard convention has been agreed upon.

Thermal Death Time Curve

The straight line fitted to the survival and destruction points plotted on logarithmic scale against the temperature on a linear scale (the number of organisms and suspending medium being specified).

Thermal Processing

The application of heat at a given temperature and for a time sufficient to produce commercial sterility of a product.

Thermocouple

Electrical output device for sensing temperature.

Thermometer Well

An external cell attached to and opening into the retort for installation of retort thermometer, controller elements, etc.

Trailing Edge

The rear or back edge of a sheet, strip, or body blank as it moves through an operation.

Under Process

Insufficient heat treatment of filled food cans during the sterilization process. Also called "undercook".

Vacuum Opener

Device for opening pouch prior to filling.

Vacuumize

To remove air from the filled container prior to closing.

Water Process

Process using water at atmospheric or greater pressure as the heating medium.

Web Roll Arbor

Support shaft for web roll.

Web Roll Brake

Adjustable brake to control web tension.